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Identification of Existing Water Quality Data

JRB Associates, Inc., Bellevue, WA

Prepared for

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In order to protect against further deterioration of Puget Sound, there is a need to establish a sensitive monitoring program to document either improvement or degradation of environmental quality. The National Atmospheric and Oceanic Administration (NOAA) has taken the initiative in this effort by sponsoring work to identify existing monitoring programs and to establish a new long-term monitoring program for Puget Sound waters. This report is an outgrowth of an EPA/NOAA interagency meeting, during which it was recognized that existing environmental quality data should be considered in design of the long-term monitoring program.

The objective of this task is to identify existing water quality and related data for Puget Sound, the Strait of Juan de Fuca and the Strait of Georgia, and to present this information. A wide diversity of chemical and biological data is included. Report number EPA 910/9-83-118a, Water Quality Dependent Water Uses in Puget Sound, identifies the water quality dependent uses and provides some background on each use. EPA 910/9-83-118b, Identification of Existing Water Quality Data, describes available data and provides information on contact persons.

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WATER QUALITY DATA

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PUGET SOUND

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FINAL REPORT

IDENTIFICATION OF EXISTING WATER QUALITY DATA

March 30, 1984

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY
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1.0 INTRODUCTION

1.1 BACKGROUND

With the demonstration of adverse environmental change in Puget Sound in recent years, there is increasing concern over the environmental quality of the Sound's waters. In order to protect against further deterioration, there is a clear need to establish a sensitive monitoring program which will adequately document either improvement or degradation of environmental quality. The National Oceanic and Atmospheric Administration (NOAA) has taken the initiative in this effort by sponsoring work to identify existing monitoring programs and to establish a new long-term monitoring program for Puget Sound waters. This report is an outgrowth of an EPA/NOAA interagency meeting, during which it was recognized that existing environmental quality data should be considered in design of the long-term monitoring program. This report represents Task II "Identification of Existing Water Quality Data" within the JRB work assignment "Coordination of Monitoring Efforts in Puget Sound".

1.2 SCOPE OF WORK

The objective of this task is to identify existing water quality and related data for Puget Sound, the Strait of Juan de Fuca and the Strait of Georgia, and to present this information in a manner that will facilitate easy access and be valuable in design of future work in Puget Sound. The water quality data included encompasses a broad diversity of data types, including virtually any parameter that could potentially serve as an indicator of environmental quality. For example, biological data of interest ranges from fecal coliform counts to population studies of marine mammals. A similarly wide diversity of

chemical and hydrographic data is included. Major emphasis was placed on data representing repeated samples at specific sites, since this information would be most applicable to a long-term monitoring program. However, data gathered during a single survey was also included if available.

The intent of this task was to identify water quality related data that is not widely known of and is not readily available to environmental managers. Therefore, efforts were directed towards gathering data from universities, community colleges, Indian tribal biologists and other similar sources that do not typically forward data to the primary management agencies. Data collections which were not funded or required by a government agency may have escaped general attention, yet potentially could be of value in a long-term monitoring program, either by establishment of baseline conditions or by extension of the temporal coverage. No attempt has been made to consider data:

1. already available to the primary governmental management agencies;
2. in STORET, WDOE, Metro or NOAA data systems; or
3. included in Jones and Stokes' recent report "Water Quality Management Program for Puget Sound"

Table 1 provides a list of contacts for water quality related data. All these contacts have been interviewed, either in person or by phone. As discussed, information available through federal and state agencies was, with a few exceptions, generally not included, though representatives of these agencies were contacted to identify alternative sources of data. A large number of sources contacted either had no data or had already submitted it to an environmental

Table 1

SOURCES OF WATER QUALITY DATA

Institution	Contact	Phone Number (area code 206 unless noted)	Contacted Primarily for Identification of Sources	No Applicable Data	Data Already Sent to Management Agencies	Included in Report (reference #)
U.S. GOVERNMENT						
NOAA	Ed Long	527-6338	X			
Fish and Wildlife Service	David Stout	753-9440	X			
	Cliff Bosley	385-1007				2.1.3
Fish and Wildlife Service, Nisqually Refuge	Steve Thompson	753-9467				2.1.1, 2.1.2
U.S. Army Corps of Engineers	Steve Martin	764-3625	X			
	Keith Phillips	764-3624	X			
U.S. Navy, Bangor	Rick Spencer	396-4192				2.1.4
U.S. Navy, Keyport	Les Tutty	396-2150			X	
U.S. Navy, Whidbey Island	Jim Johnston	257-2186		X		
U.S. Navy, Bremerton	Burley Sharbaugh	476-4049			X	
U.S. Air Force, Mukilteo	Lionel McIntosh	355-4122				2.1.6
STATE AGENCIES						
Washington Department of Fisheries	Eric Hurlburt	753-6749	X			
	Darryl Mills	964-7246		X		
	Stan Hamner	857-4324				2.2.3
Department of Natural Resources	Doug Magoon	753-3703	X			
	Dave Jamison	753-3703	X			
	Tom Mumford	753-3703				2.2.2
Department of Social and Health Services	Jack Lilja	753-5959	X			2.2.1
Wash. Dept. of Ecology, Padilla Bay Est. Sanc.	Terry Stevens	428-1558				2.2.4
Wash. Dept. of Ecology	Glen Grace	459-6071	X			
	Kevin Anderson	459-6061	X			
COUNTY PLANNERS						
Snohomish County	Denise Lello	259-9313		X		
King County	Ray Watkins	587-2722		X		
Whatcom County	Ann Wessell	676-6907		X		
Jefferson County	David Goldsmith	385-1427		X		
Skagit County	David Bough	336-9333		X		
Kitsap County	Renee Beam	876-7152		X		
COUNTY HEALTH DEPARTMENTS						
Jefferson County	Randy Durant	385-0722		X		
Kitsap County	Don Miles	478-5285				2.3.2
King County	Jim Hendrickson	244-6000				2.3.1
	Ray Watkins	587-2722				2.3.1
Pierce County	Don Oliver	593-4770				2.3.1
Snohomish County	Dave Compton	259-9440				2.3.1
Whatcom County	Environ Health Sec.	676-6724				2.3.1
Clallam County	Environ Health Sec.	452-7831				2.3.1
CITIES						
Bellingham Public Works	Bill McCort	676-6850		X		
UNIVERSITIES						
Univ. of Washington, Dept. of Oceanography	Roy Carpenter	543-8535				2.4.3
	Alyn Duxbury	543-6600	X			
	Mike Landry	543-0147				2.4.1
	Karl Lorenzen	543-8597				2.4.2
Univ. of Washington, Dept. of Zoology	W. Thomas Edmondson	543-1669		X		
	Alan Kohn	543-1629				2.4.4, 2.4.5
Univ. of Washington, Dept. of Fisheries	Ken Chew	543-4290			X	
	Bruce Miller	543-2135			X	
	Charles Simenstad	543-7185				2.4.6, 2.4.7
	Jerry Stober	543-9041				2.4.8-2.4.16
Univ. of Washington, Friday Harbor Lab	Dennis Willows	543-1484		X		
	Dick Strathman	543-1484				2.4.17

Table 1 (cont'd)

Institution	Contact	Phone Number (area code 206 unless noted)	Contacted Primarily for Identification of Sources	No Applicable Data	Data Already Sent to Management Agencies	Included in Report (reference #)
Western Washington Univ.	Burt Weber	676-3509			X	
Pacific Lutheran Univ.	Dick McGinnis	535-7561				2.4.18
Eastern Washington Univ.	Alan Scholz	359-6397				2.4.19
Univ. of Puget Sound	Eric Lindgren	756-3121				2.4.20
Seattle Univ.	David Brubaker	626-5620		X		
	Bob Smith	626-6739		X		
Univ. of British Columbia	Timothy Parsons	(604)228-4273				2.4.22
	Alan Lewis	(604)228-3278				2.4.21
Univ. of Victoria	Derrek Ellis	(604)721-7106				2.4.23
Patricia Bay	Galyn Greer	(604)656-8217		X		
COLLEGES						
Evergreen State College	Mike Baug	866-6000			X	
	Steve Herman	866-6000 x6063				2.5.1, 2.5.2
	Pete Taylor	866-6000 x6730		x		
Walla Walla College	Joe Galusha	(509)527-2603				2.5.3, 2.5.4
COMMUNITY COLLEGES						
Shoreline Community College	Jack Serwold	546-4101				2.6.1, 2.6.2
	Bob Harman	546-4101				2.6.1, 2.6.2
Olympic Community College	Don Seavy	478-4557				2.6.3, 2.6.4
Peninsula Community College	James Walton	452-9277 x272		X		
Highline Community College	Gina Erickson	878-3710 x525				2.6.5
Seattle Central Community College	Allison Duxbury	587-4080		X		
Bellevue Community College	Art Haynes	641-2321		X		
Green River Community College	Dennis White	833-9111		X		
Bellingham Voc. Tech.	Earl Steele	676-6494		X		
HIGH SCHOOLS						
Highland School District	Lauren Rice	433-2524				2.7.1
PORTS						
Port of Bellingham	Don Ellis	676-2500			X	
Port of Everett	Harry Winder	259-0246			X	
Port of Seattle	John Dohrmann	382-3000			X	
Port of Tacoma	Gary Kuczinski	383-5841			X	
CONSULTING FIRMS						
Battelle Northwest	Jack Anderson	683-4151				2.8.3, 2.8.4
Cascadia Research	Steve Speich	943-7325				2.8.3, 2.8.4
ITT-Rainier	Roger Tollefson	426-4461			X	
AQUARIA						
Seattle Aquarium	Bill Bruin	625-4358		X		2.9.1
Pt. Defiance Zoo and Aquarium	Jim Short	591-5337		X		
	John Rupp	591-5337				2.9.2
OTHER						
Domsea Farms	Mike Garner	479-9941				2.10.1
Olympia Oyster Growers Assoc.	Dave MacMillan	426-3354		X		
Sundquist Labs	Paul Cassidy	293-6800				2.10.2
Penn Cove Blue Mussels	Peter Jefferds	678-4803		X		
Tulalip Tribes	Dave Somers	653-4588				2.10.3, 2.10.4
Point No Point Treaty Council	Will Sandoval	297-3422		X		

management agency. These contacts are indicated on Table 1 but are not discussed further in this report. For those institutions or individuals which did have data, a reference number is given referring to the corresponding data profile in Section 2.0.

2.0 WATER QUALITY DATA PROFILES

2.1 U.S. GOVERNMENT

REFERENCE NO.: 2.1.1

INSTITUTION: U.S. Fish And Wildlife Service, Nisqually Refuge

CONTACT: Mr. Steve Thompson, Nisqually National Wildlife Refuge, 100 Brown Farm Road, Olympia, WA 98506; Phone (206) 753-9467

DATA DESCRIPTION: Aerial surveys of waterfowl populations. Seal counts are also made during the surveys but population estimates are unreliable

LOCATION: Most of Puget Sound. Flights commencing in Budd and Eld Inlets, continuing up the eastern shore including Elliott and Commencement Bays, and continuing northward to the Canadian border. Flights had previously included Hood Canal northwards to Dungeness area, but these surveys have been discontinued.

PERIOD/FREQUENCY: 1978 to present and ongoing. Monthly surveys from October to January in past years, currently extending the monthly surveys from October to March.

DATA FORMAT: Raw data files

REFERENCE NO.: 2.1.2

INSTITUTION: U.S. Fish and Wildlife Service

CONTACT: Mr. Steve Thompson, Nisqually National Wildlife Refuge, 100 Brown Farm Road, Olympia, WA 98506; Phone (206) 753-9467

DATA DESCRIPTION: Ground surveys of seabird populations.

LOCATION: San Juan Islands

PERIOD/FREQUENCY: 1979 to present and ongoing. Surveys made annually each summer.

DATA FORMAT: Data incorporated in "Catalog of Washington Seabird Colonies" (in press) by Steve Speich of Cascadia Research.

REFERENCE NO.: 2.1.3

INSTITUTION: U.S. Fish and Wildlife Service

CONTACT: Mr. Cliff Bosley, U.S. Fish and Wildlife Service, Marrowstone Field Station, Nordland, WA 98339; Phone (206) 385-1007

DATA DESCRIPTION: Concentrations of PCB and other chlorinated organic pesticides in sediments and in the tissues of various marine organisms. Samples collected by diver.

LOCATION: Discovery Bay (starry flounder, English sole)
Skagit Bay (starry flounder, mussels, sediments)
Dungeness River (sediment)

PERIOD/FREQUENCY: Though originally conceived as a monitoring program, the future of the program is in doubt after a single sampling period in 1983.

DATA FORMAT: Technical report.

REFERENCE NO.: 2.1.4

INSTITUTION: U.S. Navy - Bangor

CONTACT: Mr. Rick Spencer, U.S. Naval Submarine Base - Bangor, Bldg. 1101, Code 8622, Bremerton, WA 98315; Phone (206) 396-4192

DATA DESCRIPTION: Monitoring program to evaluate the impact of naval activities on the water quality of Hood Canal. Water samples taken for trace metals (Cr, Cu, Fe, Pb, Hg, Ag, Zn, Ni), nutrients (ammonia, nitrates, nitrites, Kjeldahl nitrogen, orthophosphate), TOC, pH, salinity, temperature and dissolved oxygen. Secchi disk readings taken concurrently with water sampling.

LOCATION: Twenty sites in Hood Canal and Dabob Bay ranging from 47° 43' 46" N to 47° 46' 29" N and 122° 42' 10" W to 122° 46' 77" W.

PERIOD/FREQUENCY: 1974 to present and ongoing. All twenty sites sampled twice per year in summer and winter.

DATA FORMAT: Raw data files. All data sent to Naval Energy and Environmental Support Activities, Port Heuneme, CA.

REFERENCE NO.: 2.1.5

INSTITUTION: U.S. Navy - Bangor

CONTACT: Mr. Rick Spencer, U.S. Naval Submarine Base - Bangor, Bldg. 1101, Code 8622, Bremerton, WA 98315; Phone (206) 396-4192

DATA DESCRIPTION: Monitoring program to evaluate the impact of naval activities on the marine fauna of Hood Canal. Molluscs and fish are collected by hand and beach seine, respectively, and measurements made of abundances and size frequency distributions.

LOCATION: Hood Canal; Bangor, WA; 47° 45" N, 122° 44' W.

PERIOD/FREQUENCY: 1973 to present and ongoing. Surveys conducted annually each summer.

DATA FORMAT: Results released every 1-3 years as technical reports available through Naval Ocean Systems Center (NOSC) or NTIS.

REFERENCE NO.: 2.1.6

INSTITUTION: U.S. Air Force - Mukilteo

CONTACT: Mr. Lionel McIntosh, Energy Management Laboratory, Aerospace Fuels Lab, Mukilteo, WA 98275; Phone (206) 355-4122

DATA DESCRIPTION: In order to address concerns of pollution from aviation fuels, hydrocarbon measurements were made in soils on Air Force property and from clams in the shallow subtidal areas of Puget Sound immediately adjacent to the facility. No evidence of elevated hydrocarbon burdens in clam tissue was noted.

LOCATION: Mukilteo

PERIOD/FREQUENCY: A single survey in the fall of 1983.

DATA FORMAT: Report by Patty Prohaska and Dave Fisher submitted to the Defense Fuel Supply Center.

2.2 STATE AGENCIES

REFERENCE NO.: 2.2.1

INSTITUTION: Washington Department of Social and Health Services

CONTACT: Mr. Jack Lilja, Washington State Dept. of Social and Health Services, Shellfish Protection Program, Olympia, WA 98504; Phone (206) 753-5959

COMMENTS: The office of Environmental Health Programs in DSHS is responsible for certifying that commercial shellfish beds meet certain standards for the protection of public health, and decertifying those beds that fail to meet these standards. Except for samples provided by county health departments (see reference no. 2.3.1) there is no ongoing monitoring program at any specific site. Samples are generally taken only in areas where there is cause for concern. Most of the sampling effort is concentrated on fecal coliforms and paralytic shellfish poisoning (PSP) though additional measurements or samples may be taken for temperature, salinity and trace metals or synthetic organics in shellfish tissue. Sampling is conducted both onsite in the areas of commercial beds and in shellfish processing plants. With the exception of some information on PSP, none of the data is computerized at this time, making it difficult to determine those sites for which data is available and the periods during which this data was collected. Data should be available for many of the commercial shellfish beds in Puget Sound and particularly those in the vicinity of population centers.

REFERENCE NO.: 2.2.2

INSTITUTION: Washington Dept. of Natural Resources

CONTACT: Mr. Tom Mumford, Research and Development Center, Washington Dept. of Natural Resources, Olympia, WA 98504; Phone (206) 753-3703

DATA DESCRIPTION: Hydrographic and chemical data from surface waters (temperature, salinity, phosphorus, nitrates, nitrites, and ammonia).

LOCATION: See below.

PERIOD/FREQUENCY:

Budd Inlet - 1979 to 1980. Daily monitoring

Squaxin Island - fall 1982 to spring 1983. Daily monitoring

Harstene Island - fall 1982 to spring 1983. Daily monitoring

McNeil Island - fall 1982 to present and ongoing. Temperature and salinity daily, nutrients weekly.

DATA FORMAT: Raw data files with portions also available on magnetic tape.

REFERENCE NO.: 2.2.3

INSTITUTION: Washington Dept. of Fisheries

CONTACT: Mr. Stan Hammer, Fox Island Net Pens, 335 Island Blvd., Fox Island, WA 98333; Phone (206) 857-4324.

DATA DESCRIPTION: Temperature and dissolved oxygen measurements taken in order to protect salmon rearing operations.

LOCATION: Fox Island

PERIOD/FREQUENCY: Mid 1970's to present and ongoing. Temperature measurements taken daily. Dissolved oxygen samples taken daily during critical periods, generally June and July.

DATA FORMAT: Raw data files.

REFERENCE NO.: 2.2.4

INSTITUTION: Padilla Bay National Estuarine Sanctuary

CONTACT: Mr. Terry Stevens, Padilla Bay National Estuarine Sanctuary, 1043 Bay View-Edison Rd., Mount Vernon, WA; Phone (206) 428-1558

COMMENTS: Padilla Bay Estuarine Sanctuary does not fund research nor perform any environmental data gathering activities independent of other institutions or government agencies. They do, however, provide facilities for research conducted under the auspices of other agencies (e.g., Ref. No. 2.4.19). Table 2 provides a summary of past research conducted in the Padilla Bay area.

Table 2

HISTORICAL RESEARCH PROGRAMS IN PADILLA BAY

List provided by Terry Stevens, Padilla Bay Estuarine Sanctuary

Type of Sampling	Agency(s)	Date	Investigator
Sulfite Waste 1946 (water quality)	Fish & Wildlife Ser. WDF	1946	Saxton-Young
Industrial Waste (water quality)	Pollution Control Commission	1957	Al Neale
Oyster (water quality)	Pollution Control Commission	1952	Al Neale
Oyster (water quality)	WDF	1950	Orlob-Neale-Lindsay
Eelgrass	WDG/Funded by Fish & Wildlife Ser.	1971-75	Bob Jeffrey
Intertidal Benthos	WWU Huxley College Funded by WDOE	1974-75, 1979	Webber-Smith
Subtidal-Eelgrass Benthos	WWU Huxley College Funded by WDOE	1976	Webber-Smith
Beach Seine (fish)	WWU Huxley College Funded by WDOE	1974-75	Webber-Smith
Marine Birds	WDG + funded by U.S.F.W.S.	1965-79	Webber-Smith
Marine Birds	John Graham Co. Funded by ACOE	1977-78	Peters-Richter
Marine Birds	U.W. funded by EPA through NOAA (MESA)	1978-79	Manuwal-Wahl
Marine Mammals	NMFS funded by NOAA (MESA)	1977-79	Robert Everitt
Land Use/Land Cover	WDG funded by OCZM through WDOE	1978	Rick Albright
Drift Sectors	John Norman Assoc. funded through WDOE	1977	John Norman
Inventory of compilation of Biota (Data)	WWU Huxley College WDF, WDG	1976	Bob Jeffrey
Inventory of compilation of Biota (Data)	WDG	1977	Sweeney

2.3 COUNTY HEALTH DEPARTMENTS

REFERENCE NO.: 2.3.1

INSTITUTION: County Health Departments

COMMENTS: The health departments of most counties bordering Puget Sound maintain a monitoring program for paralytic shellfish poisoning. Shellfish are collected, often by volunteers, and forwarded to DSHS for analysis. Depending on the county, these programs have generally been established for 2-5 years with sampling on a biweekly or monthly basis from the spring to the fall. Information on these programs is available from the Environmental Health sections of county health departments. Selected contacts include Don Oliver (Pierce County), Dave Compton (Snohomish County) and Jim Hendrickson and Ray Watkins (King County).

REFERENCE NO: 2.3.2

INSTITUTION: Kitsap County Health Department

CONTACT: Mr. Don Miles, Kitsap County Health Department, 109 Austin Drive, Bremerton, WA 98310; Phone (206) 478-5285

DATA DESCRIPTION: Measurements of fecal coliform and dissolved oxygen in surface waters.

LOCATION: 30-40 nearshore stations in Puget Sound and Hood Canal surrounding Kitsap County.

PERIOD/FREQUENCY: Fecal coliforms have been collected quarterly since 1979. In the last two years, however, they have been collected only during summer months. Dissolved oxygen data has been collected at the same stations and times from 1978-1982.

DATA FORMAT: Raw data files

COMMENTS: Fecal coliform data may not be very meaningful because it is not collected under similar oceanographic conditions (tidal changes, etc. can effect numbers) and replicates are not taken.

2.4 UNIVERSITIES

REFERENCE NO.: 2.4.1

INSTITUTION: University of Washington

CONTACT: Dr. Mike Landry, Dept. of Oceanography WB-10, Univ. of Washington, Seattle, WA 98195; Phone (206) 543-0147

DATA DESCRIPTION: Research to examine temporal variation of Puget Sound zooplankton communities. Vertical plankton samples taken, 200 m to surface, daytime sampling.

LOCATION: Single station in the main basin of Puget Sound northwest of West Point, 47° 41' N, 122° 27' W.

PERIOD/FREQUENCY: April - November 1980. Weekly sampling

DATA FORMAT: Samples unanalyzed

REFERENCE NO.: 2.4.2

INSTITUTION: University of Washington

CONTACT: Dr. Karl Lorenzen, University of Washington, Dept. of Oceanography Seattle, WA 98195; Phone (206) 543-8597

DATA DESCRIPTION: Research directed towards understanding of phytoplankton dynamics and seasonal variability. Measurements made of phytoplankton pigment concentrations and primary productivity throughout a vertical profile to a depth of 100 m.

LOCATION: Dabob Bay

PERIOD/FREQUENCY: 1975 to present and ongoing. A single site occupied at monthly intervals.

DATA FORMAT: Raw data files.

REFERENCE NO: 2.4.3

INSTITUTION: University of Washington

CONTACT: Dr. Roy Carpenter, Dept. of Oceanography WB-10, University of Washington, Seattle, WA 98195; Phone (206) 543-8535

COMMENTS: Work by Dr. Carpenter and his students, often in collaboration with investigators from other institutions, provides a great deal of information on trace metals in synthetic organics in Puget Sound sediments. None of the work is of a monitoring nature but could potentially be valuable in establishment of baseline conditions. Most of the data has not been directly forwarded to a primary environmental management agency, and therefore is within the scope of this work, however, it has been widely disseminated in the scientific literature. A selected list of publications of pertinence to Puget Sound is shown below:

Barrick, R. 1982. Flux of aliphatic and polycyclic aromatic hydrocarbons to central Puget Sound from Seattle (West Point) primary sewage effluent. Environ. Sci. & Tech. 16:682-692.

Barrick, R.C. and J.I. Hedges. 1981. Hydrocarbon geochemistry of the Puget Sound Region II. Sedimentary diterpenoid, steriod and triterpenoid hydrocarbons. Geochim. Cosmochim. Acta 45:381-392.

Barrick, R.C., J.I. Hedges and M.L. Peterson. 1980. Hydrocarbon geochemistry of the Puget Sound Region 1. Sedimentary acyclic hydrocarbons. Geochim. Cosmochim. Acta 44:1349-1362.

Bothner, M.H. and R. Carpenter. 1973. The rate of mercury loss from contaminated estuarine sediments in Bellingham Bay, Washington. In: Proceedings of the First Annual NSF Trace Contaminants Conference, Oak Ridge National Laboratory. pp. 198-210.

Carpenter, R., M.L. Peterson and J.T. Bennett. In review. ^{210}Pb-derived sediment accumulation and mixing rates for the greater Puget Sound region. Marine Geology.

Carpenter, R. M.L. Peterson and R.A. Jahnke. 1978. Sources, sinks and cycling of arsenic in the Puget Sound region. In: Estuarine Interactions. Edited by M.L. Wiley, Academic Press. pp. 459-480.

Crecilius, E.A. and R. Carpenter. 1973. Arsenic distributions in waters and sediments of the Puget Sound region. In: Proceedings of the First Annual NSF Trace Contaminants Conference, Oak Ridge National Laboratory. pp. 615-625.

Crecilius, E.A., M.H. Bothner and R. Carpenter. 1975. The geochemistries of arsenic, antimony, mercury and related elements in sediments of Puget Sound, Washington. Environmental Science & Tech. 9:325-333.

Furlong, E. and R. Carpenter. 1982. Distributions of azaarenes in Puget Sound sediments. Geochim. Cosmochim. Acta 46:1385-1396.

Peterson, M.L. and R. Carpenter. 1983. Biogeochemical processes affecting total arsenic and arsenic species distributions in an intermittently anoxic fjord. Marine Chemistry. 12:295-321.

Prahl, F.G., J.T. Bennett and R. Carpenter. 1980. The early diagenesis of aliphatic hydrocarbons and organic matter in sedimentary particles from Dabob Bay, WA. Geochim. Cosmochim. Acta 44:1967-1976.

Prahl, F.G. and R. Carpenter. 1979. The role of zooplankton fecal pellets in the sedimentation of polycyclic aromatic hydrocarbons in Dabob Bay, WA. Geochim. Cosmochim. Acta 43:1959-1972.

REFERENCE: 2.4.4

INSTITUTION: University of Washington

CONTACT: Dr. Alan Kohn, Dept. of Zoology NJ-15, Univ. of Washington, Seattle, WA 98195; Phone (206) 543-1629

DATA DESCRIPTION: Zooplankton collections are made in connection with a class on natural history of marine invertebrates. Vertical tows, in 40 feet of water, are made with a 202 micron net. Organisms are identified to major group and the relative abundance of each group determined.

LOCATION: Elliott Bay; early samples taken at Seacrest Marina, sampling site changed to Seattle Aquarium around 1978.

PERIOD/FREQUENCY: Approximately 1970 to present and ongoing. Samples taken every two weeks, March through May.

DATA FORMAT: Raw data files.

COMMENTS: Because of non-quantitative sampling and incomplete taxonomy, the value of this data is limited. Samples have not been archived so further analysis is impossible.

REFERENCE: 2.4.5

INSTITUTION: University of Washington

CONTACT: Dr. Alan Kohn, Dept. of Zoology NJ-15, Univ. of Washington, Seattle, WA 98195; Phone (206) 543-1629

DATA DESCRIPTION: Patterns of intertidal zonation of fauna and flora are examined in connection with a class on natural history of marine invertebrates. The dominant fauna within each zone are noted and the maximum height of each faunal band determined.

LOCATION: Edmonds ferry dock, data collected on both north and south side.

PERIOD/FREQUENCY: Approximately 1965 to present and ongoing. A single survey made every April.

DATA FORMAT: Raw data files.

REFERENCE: 2.4.6

INSTITUTION: University of Washington

CONTACT: Dr. Charles Simenstad, Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA 98195; Phone (206) 543-7185

DATA DESCRIPTION: The interactions between juvenile pink and chum salmon and their prey were investigated as part of an effort to evaluate potential impacts of naval construction actitivites. Temporal and spatial changes in the salmon and zooplankton communities were examined, as well as trophic interactions between these communities. Juvenile salmon migration behavior and food habits were documented by beach seine, townet collections and stomach content analysis. Epibenthic zooplankton were collected by a diver operated suction pump. Neritic zooplankton were collected by oblique tows with a 60 cm bongo net.

LOCATION: Brown Point area of Hood Canal

PERIOD/FREQUENCY:

Salmon - 1975 to 1979

Zooplankton - December 1976 to July 1977 and February to December 1978; biweekly samples: January to June 1979; monthly sampling: May 15, 1978; diel series.

DATA FORMAT: Data on tape and in technical report.

Simenstad, C.A., W.J. Kinney, S.S. Parker, E.O. Salo, J.R. Cordell and H. Buechuer. 1980. Prey community structure and trophic ecology of outmigrating juvenile chum and pink salmon in Hood Canal, Washington--A synthesis of three years' studies 1977-1979. Univ. of WA, Coll. of Fisheries, Fisheries Res. Inst. FRI-UW-8026.

COMMENTS: Epibenthic zooplankton collections included two replicates in 1977 and triplicate samples in 1978/1979.

REFERENCE: 2.4.7

INSTITUTION: University of Washington

CONTACT: Dr. Charles Simenstad, Fisheries Research Institute, College of Fisheries, Univ. of Washington, Seattle, WA 98195; Phone (206) 543-7185

DATA DESCRIPTION: The use of the DuPont-Nisqually delta nearshore area by salmon and other fish and their trophic relationships were investigated to evaluate the effects of the construction and operation of a cargo loading dock. Fish were sampled by beach seine, trynet, townet, purse seine and by divers. Plankton were sampled using a 60 cm bongo net with a 0.5 mm mesh size.

LOCATION: Nisqually Flats and southern Anderson Island; three sites in March 1971; two of these plus four more in February 1978.

PERIOD/FREQUENCY: March 1977 to July 1978 at weekly, biweekly or monthly intervals, depending on data type

DATA FORMAT: Data on tape and in technical report.

Fresh, K.L., D. Rabin, C.A. Simenstad, E.O. Salo, K. Garrison, L. Matheson. 1978. Fish ecology studies in the Nisqually Reach are of southern Puget Sound, Washington. Univ. of Washington, College of Fisheries, Fisheries Res. Inst. FRI-UW-7812. Annual Progress Report, March 1977 to June 1978, submitted to Weyerhauser Corp.

REFERENCE: 2.4.8

INSTITUTION: University of Washington

CONTACT: Dr. Jerry Stober, Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA 98195; Phone (206) 543-9041

COMMENTS: In an effort to evaluate the potential ecological impacts of a nuclear power plant, a multi-disciplinary study of the fisheries and marine ecology of northern Skagit Bay in the vicinity of Kiket Island was undertaken by the Fisheries Research Institute. Because of the diverse data collected, each component of the research is considered individually in profiles 2.4.9 through 2.4.16. All of the reports cited in these sections can be found in:

Stober, Q.J. and E.O. Salo. 1973. Ecological studies of the proposed Kiket Island nuclear power site. Univ. of Washington College of Fisheries, Fisheries Research Institute, FRI-UW-7304. Final report, Sept. 1, 1969 to Feb. 28, 1973 submitted to Snohomish County P.U.D. and Seattle City Light.

REFERENCE: 2.4.9

INSTITUTION: University of Washington

CONTACT: Dr. Jerry Stober, Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA 98195; Phone (206) 543-9041

DATA DESCRIPTION: Hydrographic data (temperature, salinity, turbidity, dissolved oxygen) from surface and bottom waters.

LOCATION: Similk Bay, North Skagit Bay, Swinomish Channel

PERIOD/FREQUENCY: 1970 to 1972. Continuous record of temperature at surface, 3 m and bottom. Grid sampling of surface waters, March to July, 1970; March to May, 1971; and March to August, 1972.

DATA FORMAT: Stober, Q.J., S.J. Walden and D.T. Griggs. Seasonal water quality in North Skagit Bay. Chap. 4, pp 7-34. In Stober et al., 1973.

REFERENCE: 2.4.10

INSTITUTION: University of Washington

CONTACT: Dr. Jerry Stober, Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA 98195; Phone (206) 543-9041

DATA DESCRIPTION: Investigation of temporal and spatial distribution of salmonids. Collections made by townet and purse seine with periodic beach walks to estimate size and abundance of juveniles.

LOCATION: Northern Skagit Bay

PERIOD/FREQUENCY: 1970 to 1972. Sampling commencing in March of each year and continuing through June or August.

DATA FORMAT: Stober, Q.J., S.J. Walden and D.T. Griggs. Juvenile salmonid migration through North Skagit Bay. Chap. 5, pp 35-69. In Stober et al., 1973.

REFERENCE: 2.4.11

INSTITUTION: University of Washington

CONTACT: Dr. Jerry Stober, Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA 98195; Phone (206) 543-9041

DATA DESCRIPTION: Investigation of temporal and spatial distribution and abundance of ichthyoplankton. Two replicate vertical plankton hauls taken from both bottom to surface and 5 m to surface. Nansen casts for temperature and salinity taken at each station prior to zooplankton sampling.

LOCATION: Northern Skagit Bay

PERIOD/FREQUENCY: January 1971 through April 1972 with sampling intervals spaced one week to one month apart. Some stations repeated as frequently as twice per cruise.

DATA FORMAT: Blackburn, J.E. Pelagic eggs and larval fish of Skagit Bay. Chap. 6, pp 71-118 In Stober et al., 1973.

REFERENCE: 2.4.12

INSTITUTION: University of Washington

CONTACT: Dr. Jerry Stober, Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA 98195; Phone (206) 543-9041

DATA DESCRIPTION: A survey of the intertidal macrofauna and macroflora was made to:

1. compile a complete list of all species present
2. describe the abundance and seasonal variation of these organisms
3. investigate the age and growth of the native littleneck clam.

Samples were taken by transects located around the perimeter of Kiket Island, with three replicates collected at each two foot tidal interval. Percent algal cover was estimated and all macrofauna enumerated.

LOCATION: Kiket Island, northern Skagit Bay

PERIOD/FREQUENCY: November 1969 to August 1970 and November 1970 to August 1971 with four sampling periods within each interval.

DATA FORMAT: Houghton, J.P. Intertidal Ecology. Chap. 7, pp 119-260 In Stober et al., 1973.

REFERENCE: 2.4.13

INSTITUTION: University of Washington

CONTACT: Dr. Jerry Stober, Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA 98195; Phone (206) 543-9041

DATA DESCRIPTION: Interactions between Dungeness crab and the macrobenthic invertebrate community were examined by confining crabs within enclosed areas and monitoring changes in the infaunal populations. Five replicate Van Veen grab samples were taken at depths of 40 and 60 feet on two transects (four stations total). Stomach content analyses were performed on flatfish and Dungeness crabs. The Dungeness crab fishery was examined by surveys of commercial and recreational fishermen, mark-recapture studies and SCUBA surveys of crab populations.

LOCATION: Northern Skagit Bay

PERIOD/FREQUENCY: 1970 to 1972 with each aspect of the work being done within a short portion of this interval.

DATA FORMAT: Mayer, D.L. Subtidal ecology. Chap. 8 pp 259-371 In Stober et al., 1973.

REFERENCE: 2.4.14

INSTITUTION: University of Washington

CONTACT: Dr. Jerry Stober, Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA 98195; Phone (206) 543-9041

DATA DESCRIPTION: Data on seasonal variation of taxa, abundance, biomass and size frequency of demersal and pelagic fishes. Samples collected by otter trawl, trynet, beach seine and midwater trawl.

LOCATION: Northern Skagit Bay

PERIOD/FREQUENCY: August, 1970 through August 1972 at approximately monthly intervals.

DATA FORMAT: Stober, Q.J., D.L. Griggs and D.L. Mayer. Species diversity of the marine fish community in North Skagit Bay. Chap. 9. pp 373-400 In Stober et al., 1973.

REFERENCE: 2.4.15

INSTITUTION: University of Washington

CONTACT: Dr. Jerry Stober, Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA 98195; Phone (206) 543-9041

DATA DESCRIPTION: Investigations to identify the potential biofouling problems on intake structures and to determine the times when antifouling procedures must be employed. Panels were submerged at various depths and exposed for varying lengths of time from 41 days to 8 months after which biofouling organisms were identified.

LOCATION: Northern Skagit Bay

PERIOD/FREQUENCY: Studies conducted during 1971 and 1972.

DATA FORMAT: Hanson, C.H. Subtidal and intertidal marine fouling on artificial substrata. Chap. 12. pp 469-485 In Stober et al., 1973.

REFERENCE: 2.4.16

INSTITUTION: University of Washington

CONTACT: Dr. Jerry Stober, Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA 98195; Phone (206) 543-9041

DATA DESCRIPTION: Identification and enumeration of abundant or economically important zooplankton from samples collected by vertical hauls. Seasonal comparisons are made, though sampling was confined to only two sampling intervals.

LOCATION: Northern Skagit Bay

PERIOD/FREQUENCY: Two samples taken in July, 1971; two samples taken in February 1972.

DATA FORMAT: Leistikow, N. Qualitative evaluation of marine zooplankton. Chap. 13, pp 487-499. In Stober et al., 1973.

REFERENCE: 2.4.17

INSTITUTION: University of Washington - Friday Harbor Laboratories

CONTACT: Dr. Dick Strathman, Friday Harbor Laboratories, Friday Harbor, WA 98250; Phone (206) 378-2165

DATA DESCRIPTION: Population studies of the barnacle, Balanus glandula with the intent of using barnacle settling and growth as an indicator of environmental quality. Settling plates are used to quantify the availability of cyprid larvae; photographs and collections are used to estimate abundance, size frequency, and other population parameters.

LOCATION: Sites established in Sinclair Inlet near the wastewater treatment facility, the West Point outfall, throughout the San Juan Islands, Victoria and Cape Flattery.

PERIOD/FREQUENCY: 1976-1980. Sampling conducted at monthly intervals from March through September each year.

DATA FORMAT: Raw data files; data analysis and interpretation not yet completed.

REFERENCE NO.: 2.4.18

INSTITUTION: Pacific Lutheran University

CONTACT: Dr. Dick McGinnis, Dept. of Biology, Pacific Lutheran University, Tacoma, WA 98447; Phone (206) 535-7561

DATA DESCRIPTION: Zooplankton Samples, both day and night.

LOCATION: Case Inlet PLU field station.

PERIOD/FREQUENCY: Samples taken intermittently during spring and summer months of 1976-1979. Additional samples taken 1979 to present on a very irregular basis for teaching purposes.

DATA FORMAT: Raw data files.

COMMENTS: Samples are sorted only to higher taxonomic level but are archived and available for further analysis.

REFERENCE NO.: 2.4.19

INSTITUTION: Eastern Washington University

CONTACT: Dr. Alan Scholz, Dept. of Biology, Eastern Washington University, Cheney, WA 99004; Phone (509) 359-6397

DATA DESCRIPTION: Radio-tracking of harbor seals to examine movements and haul out behavior. Future studies are planned to determine the role of harbor seals in marine ecosystems (energy budgets, population size, etc.)

LOCATION: Padilla Bay

PERIOD/FREQUENCY: June 1983 to present. Continuation dependent upon additional funding.

DATA FORMAT: Report to Washington Sea Grant in preparation.

REFERENCE NO.: 2.4.20

INSTITUTION: University Of Puget Sound

CONTACT: Dr. Eric Lindgren, University of Puget Sound, 1500 N. Warner, Tacoma, WA 98416; Phone (206) 765-3121

DATA DESCRIPTION: Hydrographic data on surface waters (temperature, salinity, dissolved oxygen, turbidity, pH)

LOCATION: The Narrows

PERIOD/FREQUENCY: 1973 to present and ongoing. Samples taken annually every fall and occasionally in spring as well.

DATA FORMAT: Student reports

COMMENT: Data collected by students as part of an introductory oceanography class. Inexperience of students makes the data highly suspect.

REFERENCE: 2.4.21

INSTITUTION: University of British Columbia

CONTACT: Dr. Alan Lewis, Dept. of Oceanography, University of British Columbia, 6270 Univ. Blvd., Vancouver, Canada V6T 1W5;
Phone (604) 228-3278

DATA DESCRIPTION: Two relatively pristine inlets were investigated as part of an industry-sponsored project to assess factors effecting the bioavailability of copper in marine and estuarine environments. Field sampling and analyses were concentrated primarily on measuring concentrations of copper and other trace metals in water and sediments, though a limited amount of data on chlorophyll *a* was also collected. Bioassays were conducted using pre-feeding developmental stages of copepods and exposing the organisms to water to which known quantities of copper had been added.

LOCATION: Knight and Jervis Inlets (Strait of Georgia, north of Vancouver)

PERIOD/FREQUENCY: Knight Inlet - monthly samples throughout 1974
Jervis Inlet - monthly samples throughout 1978

DATA FORMAT: Technical reports available for each inlet.

REFERENCE: 2.4.22

INSTITUTION: University of British Columbia

CONTACT: Dr. Timothy Parsons, Dept. of Oceanography, University of British Columbia, Vancouver, British Columbia, Canada, V6T-1W5; Phone (604) 228-4273.

COMMENTS: The University of British Columbia has no program designed to monitor the environmental quality of the Strait of Georgia. A large number of research programs have been and are being conducted though none involve sampling over a sufficient duration to be considered monitoring. Several of the more notable research programs include:

1. Biological fronts in the Strait of Georgia - The dynamics and productivity of frontal systems in the Strait have been studied for several years by Dr. Parsons and others. This work involves measurements of chlorophyll a throughout the Strait of Georgia with some additional samples taken for hydrographic data, nutrients, and zooplankton density. Publications include:

   Parsons, J.R. R.I. Perry, E.D. Nutbrown, W. Hsieh and C.M. Lalli. 1983. Frontal zone analysis at the mouth of Saanich Inlet, British Columbia, Canada. Mar. Biol. 73:1-5.

   Parsons, J.R., J. Stronach, G.A. Borstad, G. Louttit and R.I. Perry. 1981. Biological fronts in the Strait of Georgia, British Columbia, and their relation to recent measurements of primary productivity. Mar. Ecol. Prog. Ser. 6:237-242.

2. Trace metals in the marine environment - Dr. A. Lewis, Ref. No. 2.4.21.

3. Hydrographic research - Publication of "Current Atlas of Juan de Fuca, Strait of Georgia" by Dr. P.B. Crean.

4. Red tides - Dr. Taylor of the University of British Columbia has been investigating dynamics of red tides in the Strait of Georgia.

REFERENCE: 2.4.23

INSTITUTION: University of Victoria

CONTACT: Dr. Derrek Ellis, Biology Dept., Univ. of Victoria, Victoria, British Columbia, Canada V8W2Y2; Phone (604) 721-7106

DATA DESCRIPTION: Since 1970 a variety of studies have been conducted to assess the environmental impacts of four sewage discharges from the City of Victoria. Water samples have been taken more or less continuously for fecal coliforms with periodic additional sampling for nutrients, trace metal sediment concentrations, and body burden of synthetic organics in biota.

LOCATION: Victoria, British Columbia

PERIOD/FREQUENCY: 1970-1982. Sampling frequency variable and with periodic gaps but generally at monthly intervals. Some sites have been revisited throughout the entire period though most sites were sampled over a shorter interval.

DATA FORMAT: A large number of reports have been released on the results of this work. A complete listing is available through Derrek Ellis of the University of Victoria or Donald Weston of JRB Associates.

2.5 STATE COLLEGES

REFERENCE NO.: 2.5.1

INSTITUTION: Evergreen State College

CONTACT: Dr. Steve Herman, Evergreen State College, Olympia, WA 98505; Phone (206) 866-6000 ext. 6063.

DATA DESCRIPTION: DDT and PCB tissue burden in a variety of species including shorebirds, falcons, mussels and seals.

LOCATION: Shorebirds and falcons: Primarily throughout southern Sound but with a few scattered collections elsewhere.

Pigeon guillemots: Budd Inlet to Seattle

Mussels: Southern Sound to Bremerton

PERIOD/FREQUENCY: 1978-1982. Semiannual collections

DATA FORMAT: Raw data files. Four papers in preparation on shorebird data.

REFERENCE NO.: 2.5.2

INSTITUTION: Evergreen State College

CONTACT: Dr. Steve Herman, Evergreen State College, Olympia, WA 98505; Phone (206) 866-6000 Ext. 6063

DATA DESCRIPTION: Population studies of dunlin including banding programs.

LOCATION: Nisqually River Delta and Kennedy Creek

PERIOD/FREQUENCY: 1974-1980. Monthly surveys

DATA FORMAT: Raw data files

COMMENTS: Dunlin populations decreased in both areas during course of study.

REFERENCE NO.: 2.5.3

INSTITUTION: Walla Walla College

CONTACT: Dr. Joseph Galusha, Dept. of Biology, Walla Walla College, College Place, WA 99324; Phone (509) 527-2603

DATA DESCRIPTION: Ground surveys of seabird nesting populations to establish the number of nests, eggs and birds. Species considered include the glaucous-winged gull, pelagic cormorant, double-crested cormorant, black oystercatcher, pigeon guillemot and tufted puffin.

LOCATION: San Juan Islands (Colville Island, Bird Rocks, Williamson's Rocks, Flower Island, Pointer Island, South Lopez Sound and Ram Island)

PERIOD/FREQUENCY: June and July of 1963 and 1970

DATA FORMAT: Data available in: Thoresen, A.C. and J.G. Galusha. 1971. A nesting population study of some islands in the Puget Sound area. The Murrelet 52(2):20-23.

REFERENCE NO.: 2.5.4

INSTITUTION: Walla Walla College

CONTACT: Dr. Joseph Galusha, Dept. of Biology, Walla Walla College, College Place, WA 99324; Phone (509) 527-2603

DATA DESCRIPTION: Ground surveys of seabird nesting populations focusing on population size estimates for several species and breeding behavior of glaucous-winged gulls.

LOCATION: Protection Island

PERIOD/FREQUENCY: 1979 to present and ongoing. Annual surveys each summer

DATA FORMAT: Data available in:

1. Galusha, J. (ms. in prep.). Seabird research on Protection Island.
2. Walla Walla College Master's theses of Banks, 1980; Roberts, 1980; McGinley-Redd, 1981; Rasmussen, 1983; Opp, 1983.

2.6 COMMUNITY COLLEGES

REFERENCE NO.: 2.6.1

INSTITUTION: Shoreline Community College

CONTACT: Mr. Jack Serwold and Mr. Bob Harman, Shoreline Community College, 16101 Greenwood Ave. N., Seattle, WA 98133; Phone (206) 546-4101

DATA DESCRIPTION: Species composition and abundances of benthic diatoms, foraminifera and macroinvertebrates as collected by 0.1 m^2 Van Veen grab sampler. Concurrent Secchi disk readings and temperature and salinity measurements at 1 and 3 meters. Sampling has recently included a plankton sample at 3 m depth.

LOCATION: Approximately 2,000 sites throughout Puget Sound, primarily in the Nisqually Delta, Central Basin, and northern Sound (Figure 1). Samples generally taken at 1, 5, 10, 20 fathoms and in the deep areas of each region.

PERIOD/FREQUENCY: Nearly all work to date has been done as single surveys with only occasional resampling of specific sites. Sampling periods are as follows:

Central Basin: 1974-1978

Central Basin north of Edmonds: 1981

Commencement Bay: 1980-1981

Everett-Port Susan: 1978-1979

Nisqually Delta: 1982

Northern Saratoga Passage-Skagit Bay: 1984

DATA FORMAT: Raw data files

COMMENTS: The level of analysis of the benthic samples is dependent upon taxonomic groups. Molluscs have been identified to species; polychaetes and other groups have generally been identified only to higher taxa.

REFERENCE: 2.6.2

INSTITUTION: Shoreline Community College

CONTACT: Mr. Jack Serwold and Mr. Bob Harman, Shoreline Community College, 16101 Greenwood Ave. N., Seattle, WA 98133; Phone (206) 546-4101

DATA DESCRIPTION: Beach transects through the intertidal zone down to low water. Substrate type and dominant organisms recorded along the length of the transect.

LOCATION: 300 transects made throughout Puget Sound with 150 of these in the San Juan Islands. The remaining 150 are scattered in the northern and central Sound and in the Nisqually Delta.

PERIOD/FREQUENCY: Early 1970's to present. No repeated sampling at specific sites.

DATA FORMAT: Raw data files and illustrations of the cross-sectional beach profiles.

REFERENCE NO: 2.6.3

INSTITUTION: Olympic Community College

CONTACT: Dr. Don Seavy, Olympic Community College, 16th and Chester, Bremerton, WA 98310; Phone (206) 478-4557

DATA DESCRIPTION: Measurements of surface water temperature, salinity, pH and dissolved oxygen along with concurrent zooplankton samples.

LOCATION: Several stations within Sinclair Inlet

PERIOD/FREQUENCY: 1977 to present and ongoing. Monthly samples but lacking the summer months.

DATA FORMAT: Raw data files

COMMENTS: Zooplankton samples only partially worked up but available for further analysis. Much of the hydrological data has been forwarded to Alan Mearns, NOAA.

REFERENCE NO: 2.6.4

INSTITUTION: Olympic Community College

CONTACT: Dr. Don Seavy, Olympic Community College, 16th and Chester, Bremerton, WA 98310; Phone (206) 478-4557

DATA DESCRIPTION: Collection of fishes and invertebrates with 12' x 100' beach seine

LOCATION: Port Washington Narrows

PERIOD/FREQUENCY: 1978 to present. Two samples per year, generally late fall and late winter

DATA FORMAT: Raw data files

COMMENTS: Collection made in the vicinity of sewage treatment plant.

REFERENCE NO.: 2.6.5

INSTITUTION: Highline Community College

CONTACT: Ms. Gina Erickson, Highline Community College, Mail Stop 15-1, S. 240th and Pacific Highway S., Midway, WA 98032; Phone (206) 878-3710 Ext. 525

DATA DESCRIPTION: Diving survey of fish and invertebrates on an artificial reef.

LOCATION: Poverty Bay

PERIOD/FREQUENCY: 1978 to present and ongoing. Annual survey each spring

DATA FORMAT: Raw data files

2.7 HIGH SCHOOLS

REFERENCE NO.: 2.7.1

INSTITUTION: Highland School District

CONTACT: Mr. Lauren Rice, Marine Technology Dept., 18010 8th Ave. S., Seattle, WA 98148; Phone (206) 433-2524

DATA DESCRIPTION: Vertical profiles of temperature, salinity and dissolved oxygen.

LOCATION: Shilshole

PERIOD/FREQUENCY: 1975 to present and ongoing, annually each May

DATA FORMAT: Raw data files

2.8 CONSULTING FIRMS

REFERENCE NO.: 2.8.1

INSTITUTION: Cascadia Research

CONTACT: Mr. Steve Speich, Cascadia Research Cooperative. Waterstreet Bldg., Suite 201, 218 1/2 West Fourth Ave., Olympia, WA 98501; Phone (206) 943-7325

DATA DESCRIPTION: Aerial surveys of all groups of marine birds.

LOCATION: Central and southern areas of Puget Sound, Everett to Olympia

PERIOD/FREQUENCY: Surveys conducted in the summer of 1982 (ground and aerial surveys), the winter of 1982-1983, and the winter of 1983-1984. Usually two days flying time per survey.

DATA FORMAT: Data available in:

Wahl, T.R. and S.M. Speich. In press. Survey of marine birds in Puget Sound, Hood Canal, and waters east of Whidbey Island, Washington, in summer 1982. West. Birds.

Speich, S.M. and T.R. Wahl. In press. Catalog of Washington seabird colonies. U.S. Dept. Interior, Fish & Wildlife Serv. Biol. Serv. Prog., FWS/OBS.

Wahl, T.R. and S.M. Speich. 1983. First winter survey of birds in Puget Sound and Hood Canal December, 1982 and February, 1983. Nongame Wildlife Prog., Wash. Dept. Game, Olympia, WA.

Wahl, T.R. and S.M. Speich. 1980. Marine bird populations in Washington waters, impact documentation and long-term monitoring. Rep. Wash. Departments of Ecol. and Game, Olympia, WA. Approx. 1,800 pp.

Wahl, T.R. and S.M. Speich. 1980. Preliminary report on marine birds in Juan de Fuca Strait and northern Puget Sound. Rep. Wash. Dept. Ecol., Olympia, WA.

REFERENCE NO.: 2.8.2

INSTITUTION: Cascadia Research

CONTACT: Mr. Steve Speich, Cascadia Research Cooperative, Waterstreet Bldg., Suite 201, 218 1/2 West Fourth Ave., Olympia, WA 98501; Phone (206) 943-7325

DATA DESCRIPTION: Ground survey of marine bird colonies.

LOCATION: 120 sites throughout San Juan Islands

PERIOD/FREQUENCY: Single survey, summer of 1983.

DATA FORMAT: Raw data files.

REFERENCE NO.: 2.8.3

INSTITUTION: Battelle Northwest

CONTACT: Dr. Jack Anderson, Battelle Pacific North West Division, Marine Research Laboratory, Route 5, Box 1000, Sequim, WA 98382; Phone (206) 683-4151

DATA DESCRIPTION: Monitoring of fecal coliform in shellfish conducted under contract to the Port of Port Angeles.

LOCATION: Sequim Bay Marina

PERIOD/FREQUENCY: 1979 to present and ongoing. Sampling conducted every two months.

DATA FORMAT: Raw data files.

REFERENCE NO.: 2.8.4

INSTITUTION: Battelle Northwest

CONTACT: Dr. Jack Anderson, Battelle Pacific North West Division, Marine Research Laboratory, Route 5, Box 1000, Sequim, WA 98382; Phone (206) 683-4151

COMMENTS: During 1972-1974 Battelle Northwest was involved in an extensive baseline study involving both chemical and biological surveys, prior to operation of the ARCO refinery at Cherry Point. This study represents a potentially valuable data base for any future monitoring efforts in the Strait of Georgia, but is still considered proprietary data by ARCO.

2.9 AQUARIA

REFERENCE NO.: 2.9.1

INSTITUTION: Seattle Aquarium

CONTACT: Mr. Bill Bruin, Seattle Aquarium, Pier 59, Seattle, WA 98101; Phone (206) 625-4358

DATA DESCRIPTION: Hydrographic and water quality measurements of aquarium intake water (temperature, salinity, pH, turbidity, total coliform, dissolved oxygen). Intake located 80 ft below surface.

LOCATION: Elliott Bay

PERIOD/FREQUENCY: 1977 to present and ongoing. Data collected intermittently in 1977. Since 1978 T, S, pH and turbidity have been collected daily, total coliform and dissolved oxygen on a weekly basis.

DATA FORMAT: Raw data files

REFERENCE NO.: 2.9.2

INSTITUTION: Point Defiance Zoo and Aquarium

CONTACT: Mr. John Rupp, Pt. Defiance Zoo and Aquarium, N. 54th St. and N. Pearl, Tacoma, WA 98407; Phone (206) 591-5223

DATA DESCRIPTION: Hydrographic measurements on aquarium intake water (temperature, salinity, dissolved oxygen, pH). Intake located 15-20 ft below surface.

LOCATION: Point Defiance

PERIOD/FREQUENCY: 1982 to present and ongoing. Sampling at irregular intervals but approximately on a monthly basis. Greatest sampling frequency in winter and spring.

DATA FORMAT: Raw data files

2.10 OTHER

REFERENCE NO.: 2.10.1

INSTITUTION: Domsea Farms, Inc.

CONTACT: Mr. Mike Garner, Domsea Farms, Inc., 4398 West Old Belfair Highway, Bremerton, WA 98312; Phone (206) 479-9941

DATA DESCRIPTION: Dissolved oxygen measurements of surface waters to protect salmon rearing operations.

LOCATION: Fort Ward (Bainbridge Island) and Orchard Point

PERIOD/FREQUENCY: 1975 to 1978. Monitoring on an irregular basis only when there is cause for concern. Most samples taken during fall months.

DATA FORMAT: Raw data files

REFERENCE NO.: 2.10.2

INSTITUTION: Sundquist Laboratory

CONTACT: Mr. Paul Cassidy, Sundquist Laboratory, 1900 Shannon Point Ave., Anacortes, WA 98221; Phone (206) 293-6800

DATA DESCRIPTION: Hydrographic data of surface waters (temperature, pH, turbidity, dissolved oxygen, total alkalinity, carbonate alkalinity, dissolved CO_2, and salinity).

LOCATION: Shannon Point, Anacortes

PERIOD/FREQUENCY: 1974 - present and ongoing (T, pH, DO turbidity). 1977 to present and ongoing (total and carbonate alkalinity, CO_2, S). Sampling frequency initially daily but currently approximately three times per week.

DATA FORMAT: Raw data files

REFERENCE: 2.10.3

INSTITUTION: Tulalip Tribes

CONTACT: Mr. Dave Somers, Tulalip Tribe, 6700 Totem Beach Road, Marysville, WA 98370; Phone (206) 653-4588

DATA DESCRIPTION: Parametrix, Inc. was contracted to conduct a baseline survey of the water quality and fisheries resources of Tulalip Bay in preparation for expansion of a salmonid hatchery operation. A wide variety of parameters were measured in the surface waters of the bay including general physical and chemical properties, nutrients, coliforms, trace metals and synthetic organics (Table 3).

LOCATION: Tulalip Bay, four stations

PERIOD/FREQUENCY: General physical/chemical properties, nutrients and microbial analyses:

April 13 to June 27, 1979; weekly sampling frequency

Metals and synthetic organics:

April 18 to June 27, 1979; sampling every third week

DATA FORMAT: Campbell, R. F. and D. E. Weitkamp. 1979. Water quality and nearshore fish investigations in Tulalip Bay, Washington, 1979. Prepared by Parametrix, Inc. for the Tulalip Tribes, Marysville, WA.

Table 3

WATER QUALITY PARAMETERS MEASURED
IN THE SURFACE WATERS OF TULALIP BAY

General Physical and Chemical Properties	Algae Pigments and Inorganic Nutrients	Sanitary Microbiological Analyses
*Temperature	Chlorophyll a	Total coliform
*Salinity	Ammonia - N	Fecal coliform
*Conductivity	Nitrite & Nitate-N	E. Coli.
*pH	Organic Nitrogen (Kjeldahl)	Fecal streptococcus
*Dissolved Oxygen	Orthophosphate-P	Total aerobic plate count
Biochemical oxygen Demand	Total Phosphate-P	
Turbidity		
Alkalinity		

Metals	Organic Residues	Other Toxics
Arsenic	DDT	PCB
Cadmium	DDD	Residual chlorine
Chromium	DDE	Total sulfide
Copper	2, 4, 5 TP	Sulfite waste liquor
Lead	2, 4 D	
Methyl-Mercury	Aldrin	
Nickel	Dieldrin	
Zinc	Endrin	
	Lindane	
	Heptachlor	
	Mirex	
	Metholxychlor	

*Depth profile

REFERENCE: 2.10.4

INSTITUTION: Tulalip Tribes

CONTACT: Mr. Dave Somers, Tulalip Tribe, 6700 Totem Beach Road, Marysville, WA 98370; Phone (206) 653-4588

DATA DESCRIPTION: Parametrix, Inc. was contracted to conduct a baseline survey of the water quality and fisheries resources of Tulalip Bay in preparation for expansion of a salmonid hatchery operation. The primary objective was to evaluate the duration and intensity of use of Tulalip Bay by artificially reared salmon. A 3 x 30 m beach seine with a 6 mm mesh was used to collect nearshore fishes. All individuals were identified to species, enumerated and an alloquot set side for length measurements.

LOCATION: Tulalip Bay, six stations

PERIOD/FREQUENCY: April 13 to June 28, 1979; weekly sampling throughout April and May, sampling conducted approximately every other day in June.

DATA FORMAT: Campbell, R. F. and D. E. Weitkamp. 1979. Water quality and nearshore fish investigations in Tulalip Bay, Washington, 1979. Prepared by Parametrix, Inc. for the Tulalip Tribes, Marysville, WA.

3.0 LOCATION OF STUDY SITES

In order to facilitate easy reference to the data profiles provided in Section 2.0, the location of the studies identified are shown on maps of Puget Sound in Figures 2-11. Figures 2-4 show the distribution of study sites by general category (i.e. biology, chemistry and hydrography). By reference to these figures, one can readily identify studies in Puget Sound in which a specific data type was collected. For users of this document with primarily a regional interest, Figures 5-11 show the distribution of study sites categorized on the basis of subregions within the Sound. By use of these figures, one can rapidly identify all studies discussed in this report which are pertinent to a specific geographic area. The subregional classification scheme employed follows that of Jones and Stokes in their recent report "Water Quality Management Programs for Puget Sound."

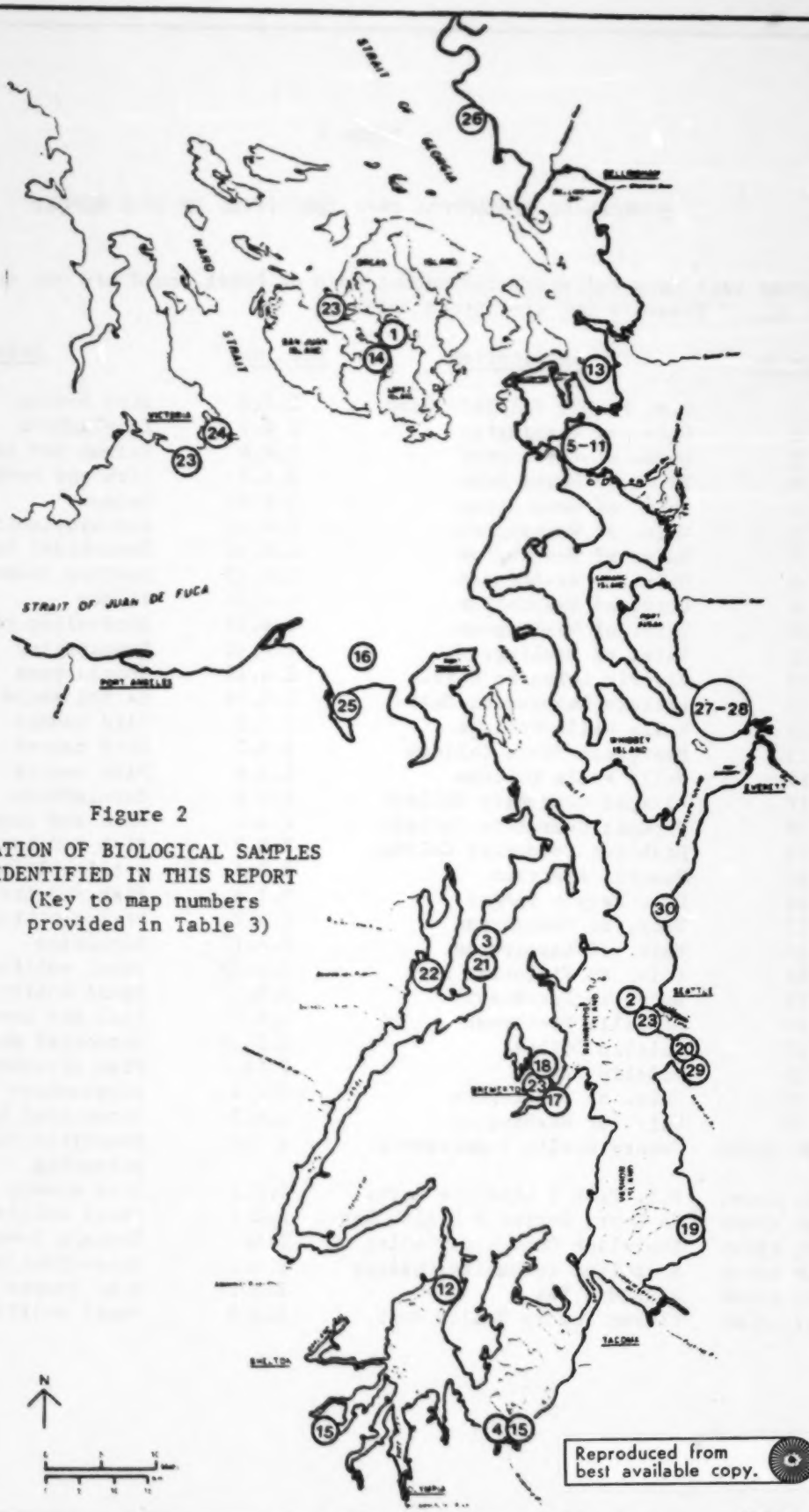

Figure 2

LOCATION OF BIOLOGICAL SAMPLES
IDENTIFIED IN THIS REPORT
(Key to map numbers
provided in Table 3)

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Table 4

SOURCES OF BIOLOGICAL DATA IDENTIFIED IN THIS REPORT

Sources with data collected throughout much of Puget Sound are not shown on the map of Figure 2 but are listed below.

Map No.	Institution	Ref. No.	Data
1	U.S. Fish & Wildlife Serv.	2.1.2	Bird counts
2	Univ. of Washington	2.4.1	Zooplankton
3	Univ. of Washington	2.4.6	Salmon and zooplankton
4	Univ. of Washington	2.4.7	Fish and zooplankton
5	Univ. of Washington	2.4.10	Salmon
6	Univ. of Washington	2.4.11	Ichthyoplankton
7	Univ. of Washington	2.4.12	Intertidal biota
8	Univ. of Washington	2.4.13	Benthic invertebrates
9	Univ. of Washington	2.4.14	Fishes
10	Univ. of Washington	2.4.15	Biofouling organisms
11	Univ. of Washington	2.4.16	Zooplankton
12	Pacific Lutheran Univ.	2.4.18	Zooplankton
13	Eastern Washington Univ.	2.4.19	Harbor seals
14	Walla Walla College	2.5.3	Bird counts
15	Evergreen State College	2.5.2	Bird counts
16	Walla Walla College	2.5.4	Bird counts
17	Olympic Community College	2.6.3	Zooplankton
18	Olympic Community College	2.6.4	Fish and invertebrates
19	Highline Community College	2.6.5	Fish and invertebrates
20	Seattle Aquarium	2.9.1	Total coliform
21	U.S. Navy - Bangor	2.1.4	Fish and invertebrates
22	Univ. of Washington	2.4.2	Phytoplankton
23	Univ. of Washington	2.4.17	Barnacles
24	Univ. of Victoria	2.4.23	Fecal coliform
25	Battelle Northwest	2.8.3	Fecal coliform
26	Battelle Northwest	2.8.4	Fish and invertebrates
27	Tulalip Tribes	2.10.3	Microbial analyses
28	Tulalip Tribes	2.10.4	Fish distribution
29	Univ. of Washington	2.4.4	Zooplankton
30	Univ. of Washington	2.4.5	Intertidal biota
not shown	County Health Departments	2.3.1	Paralytic shellfish poisoning
not shown	U.S. Fish & Wildlife Serv.	2.1.1	Bird counts
not shown	WA Dept. Social & Health Serv.	2.2.1	Fecal coliform, PSP
not shown	Shoreline Community College	2.6.1	Benthic invertebrates
not shown	Shoreline Community College	2.6.2	Intertidal biota
not shown	Cascadia Res.	2.8.1	Bird counts
not shown	Kitsap County Health Dept.	2.3.2	Fecal coliform

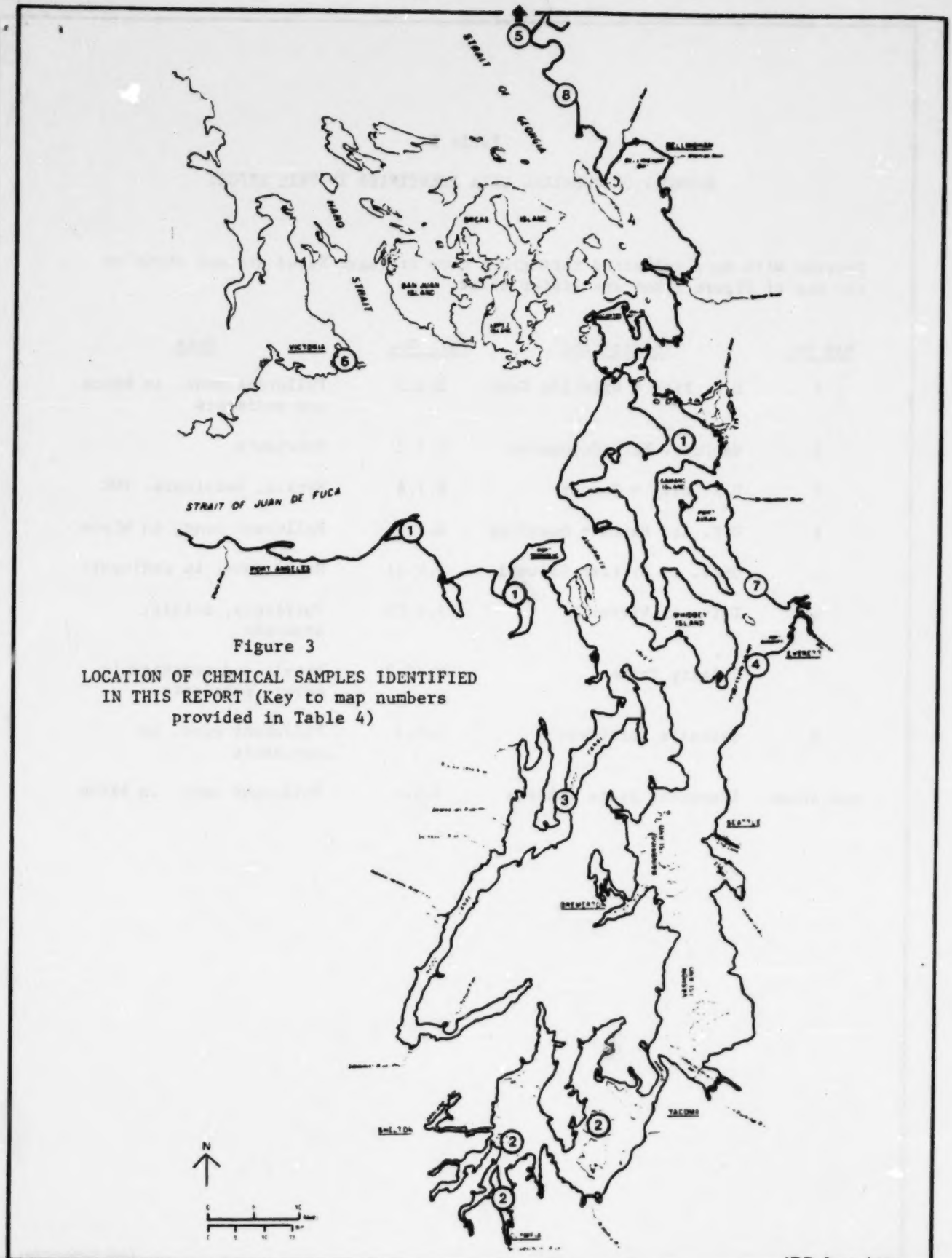

Figure 3

LOCATION OF CHEMICAL SAMPLES IDENTIFIED IN THIS REPORT (Key to map numbers provided in Table 4)

Table 5

SOURCES OF CHEMICAL DATA IDENTIFIED IN THIS REPORT

Sources with data collected throughout much of Puget Sound are not shown on the map of Figure 3 but are listed below.

Map No.	Institution	Ref. No.	Data
1	U.S. Fish & Wildlife Serv.	2.1.3	Pollutant conc. in biota and sediments
2	WA Dept. Nat. Resources	2.2.2	Nutrients
3	U.S. Navy - Bangor	2.1.4	Metals, nutrients, TOC
4	U.S. Air Force - Mukilteo	2.1.6	Pollutant conc. in biota
5	Univ. of British Columbia	2.4.21	Metal conc. in sediments
6	Univ. of Victoria	2.4.23	Nutrients, metals, organics
7	Tulalip Tribes	2.10.3	Metals and organics in water, nutrients
8	Battelle Northwest	2.8.4	Pollutant conc. in sediments
not shown	Evergreen State College	2.5.1	Pollutant conc. in biota

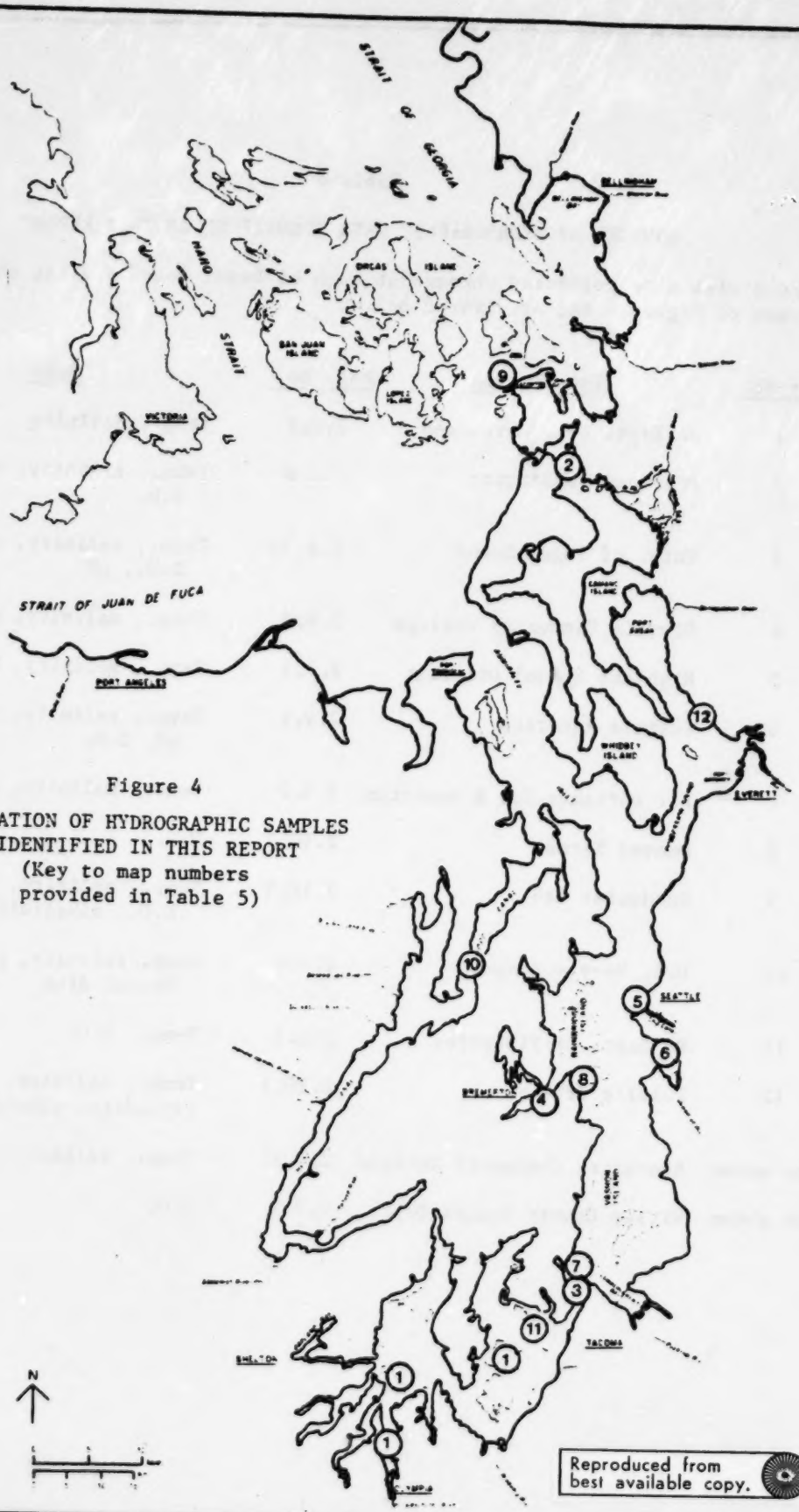

Figure 4

LOCATION OF HYDROGRAPHIC SAMPLES
IDENTIFIED IN THIS REPORT
(Key to map numbers
provided in Table 5)

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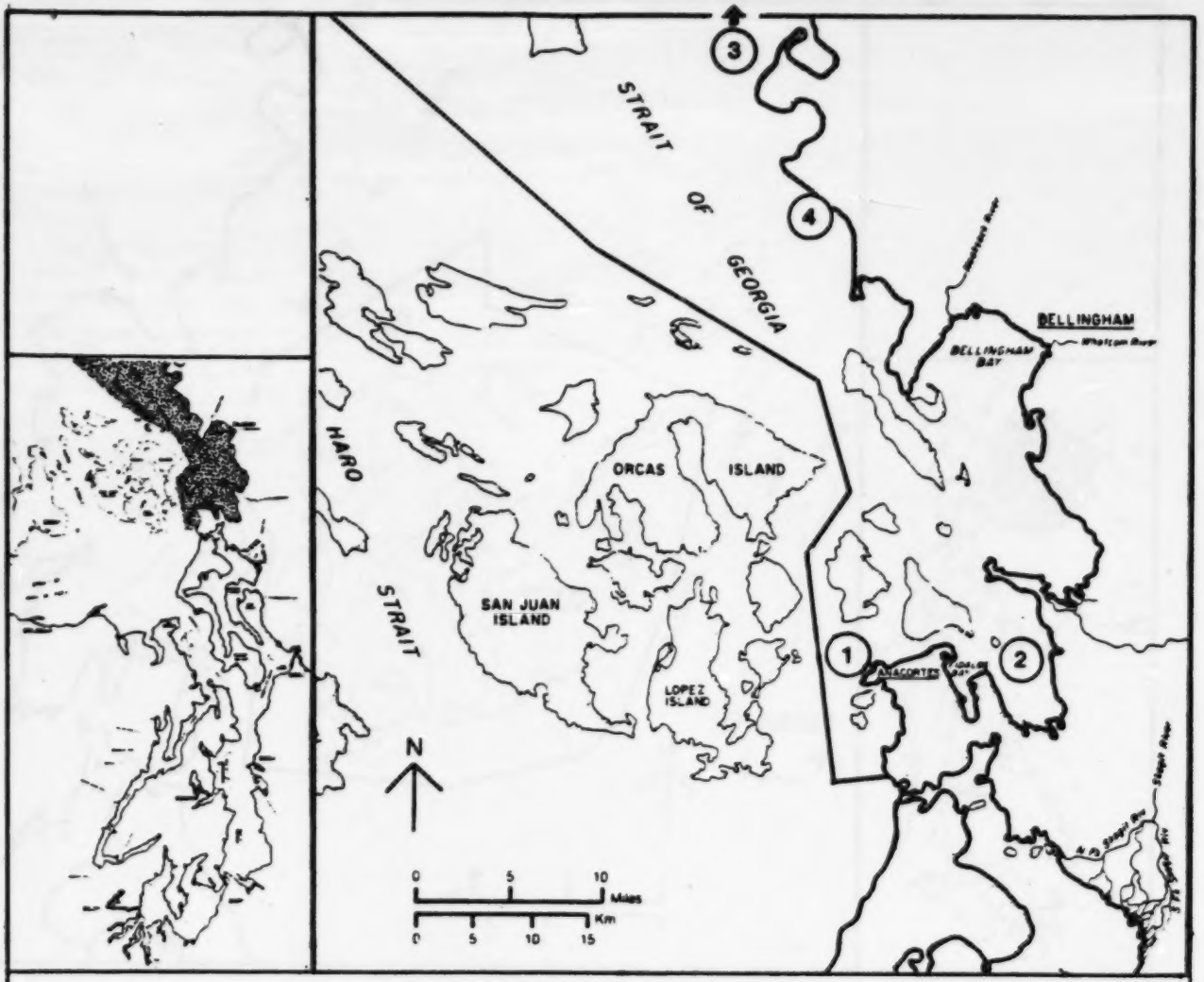
Table 6

SOURCES OF HYDROGRAPHIC DATA IDENTIFIED IN THIS REPORT

Sources with data collected throughout much of Puget Sound are not shown on the map of Figure 4 but are listed below.

Map No.	Institution	Ref. No.	Data
1	WA Dept. Nat. Resources	2.2.2	Temp., salinity
2	Univ. of Washington	2.4.9	Temp., salinity, turbidity, D.O.
3	Univ. of Puget Sound	2.4.20	Temp., salinity, turbidity, D.O., pH
4	Olympic Community College	2.6.3	Temp., salinity, pH, D.O.
5	Highland School District	2.7.1	Temp., salinity, D.O.
6	Seattle Aquarium	2.9.1	Temp., salinity, turbidity, pH, D.O.
7	Pt. Defiance Zoo & Aquarium	2.9.2	Temp., salinity, D.O., pH
8	Domsea Farms	2.10.1	D.O.
9	Sundquist Lab	2.10.2	Temp., salinity, turbidity, D.O., alkalinity, CO_2
10	U.S. Navy - Bangor	2.1.4	Temp. salinity, pH, D.O., Secchi disk
11	WA Dept. of Fisheries	2.2.3	Temp., D.O.
12	Tulalip Tribes	2.10.3	Temp., salinity, pH, D.O., turbidity, alkalinity
not shown	Shoreline Community College	2.6.1	Temp., salinity, turbidity
not shown	Kitsap County Health Dept.	2.3.1	D.O.

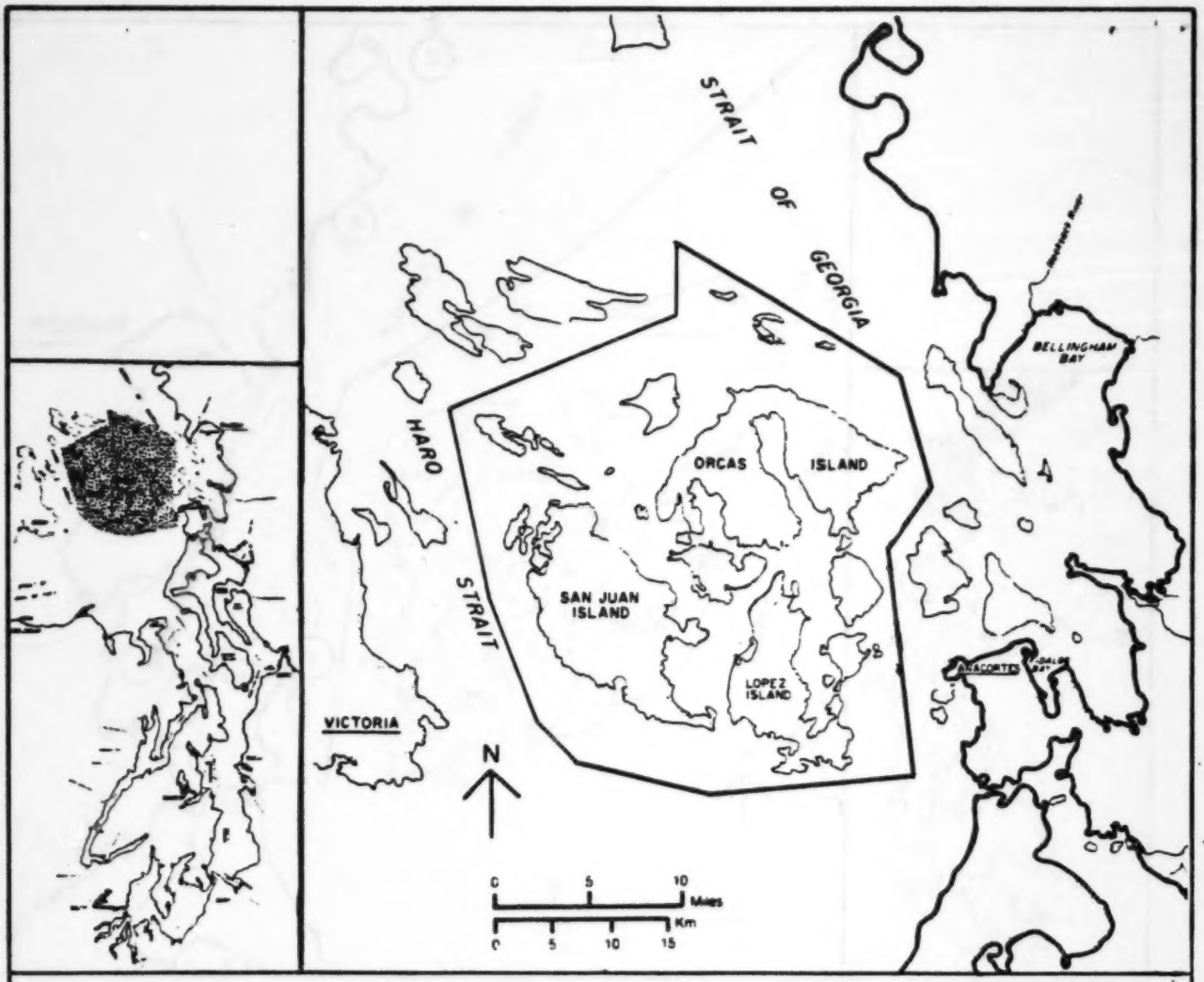


Map No.	Institution	Ref. No.	Data
1	Sundquist Lab	2.10.2	Hydrographic Data
2	Eastern Washington Univ.	2.4.19	Harbor Seal Population Studies
3	Univ. British Columbia	2.4.21	Metal Conc. in Sediments
4	Battelle Northwest	2.8.4	Fish and Invertebrates, Pollutant Conc. in Sediments
Not Shown	U.S. Fish & Wildlife Serv.	2.1.1	Bird Counts

Figure 5

STRAIT OF GEORGIA: LOCATION OF IDENTIFIED STUDY SITES

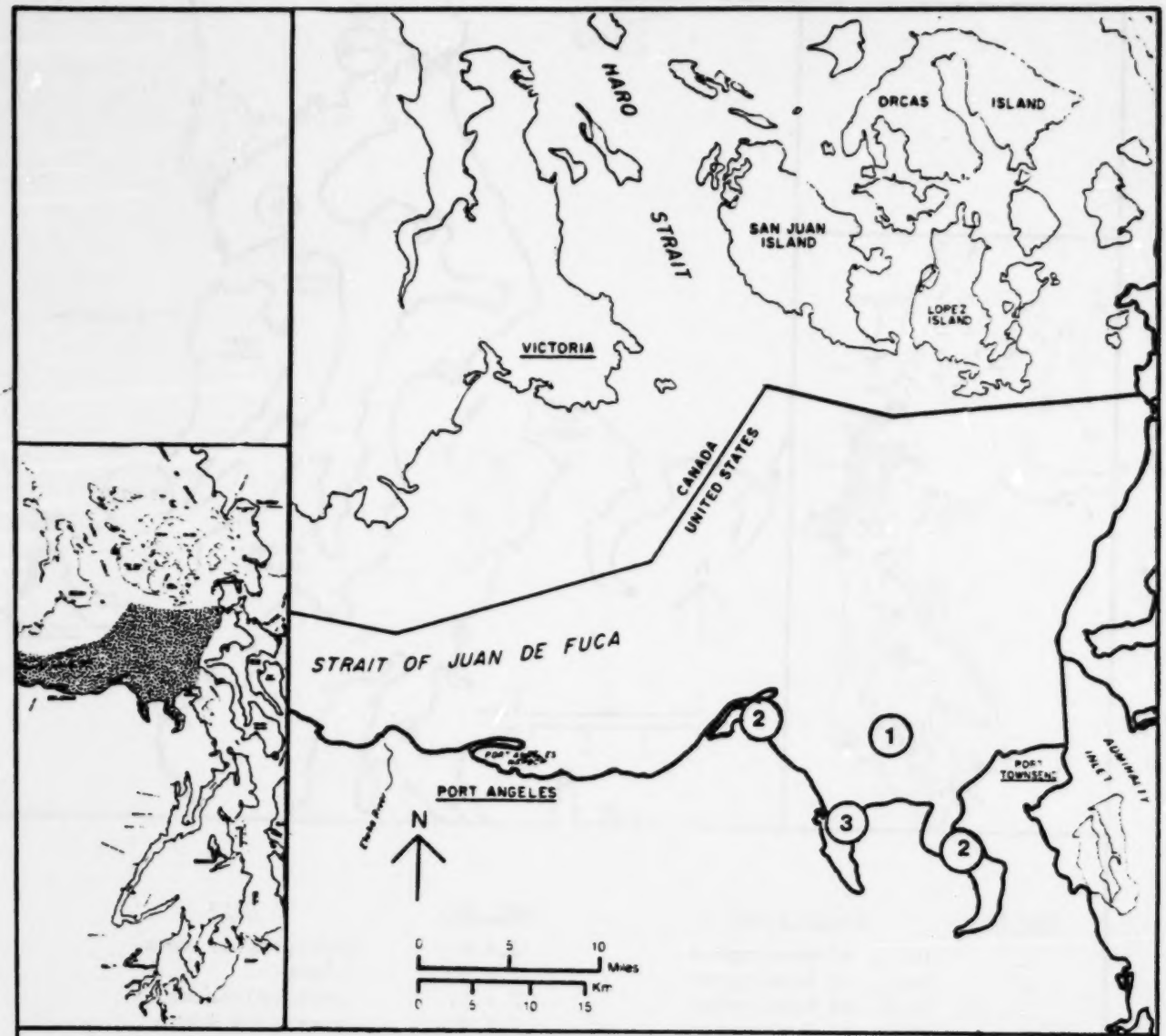
(Studies with collection sites scattered throughout much of the area are not shown)



Map No.	Institution	Ref. No.	Data
Not Shown	U.S. Fish & Wildlife Serv.	2.1.2	Bird Counts
Not Shown	Walla Walla College	2.5.3	Bird Counts
Not Shown	Shoreline Community College	2.6.2	Intertidal Biota
Not Shown	Univ. of Washington	2.4.17	Barnacles

Figure 6

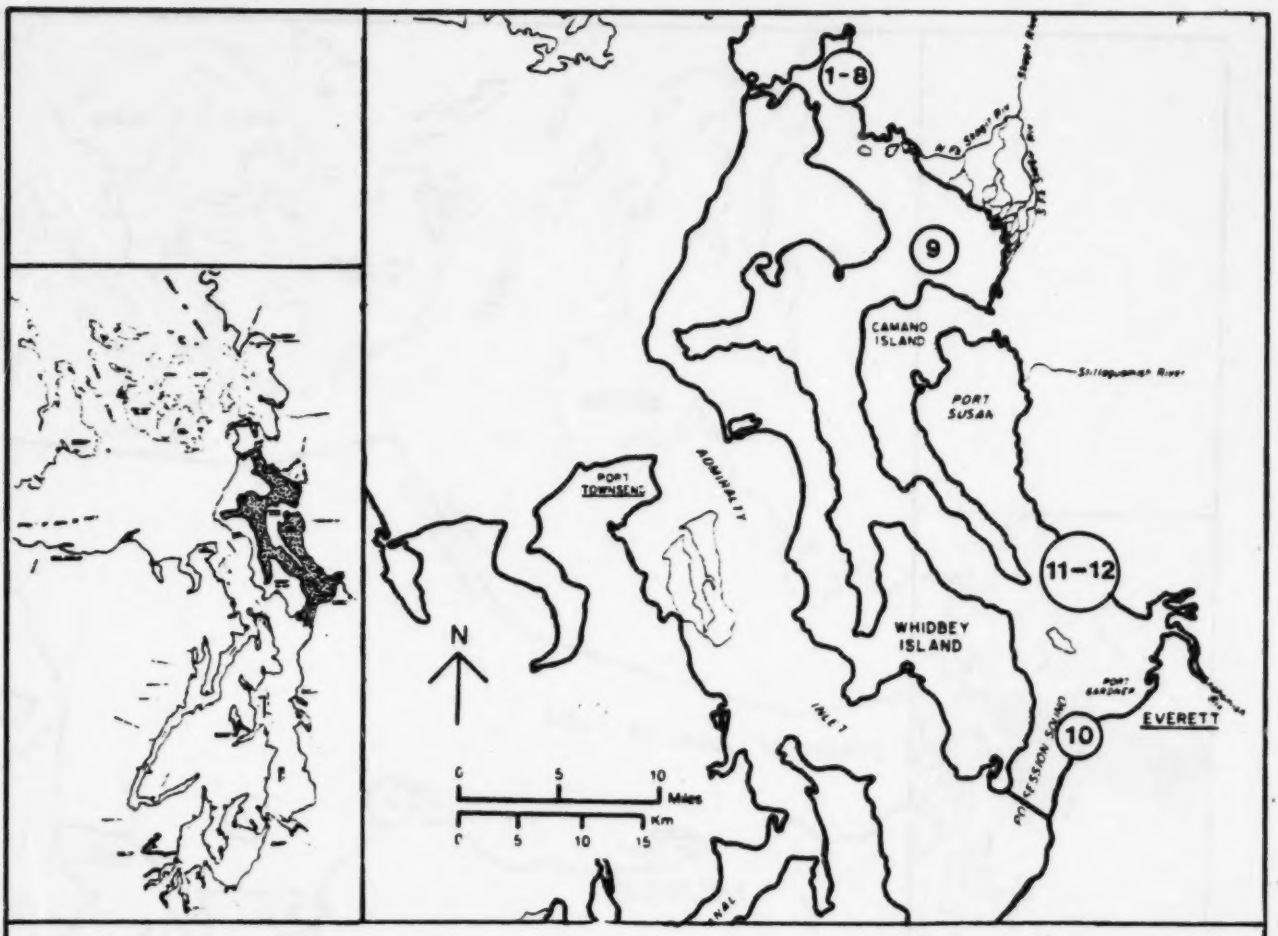
SAN JUAN ISLANDS: LOCATION OF IDENTIFIED STUDY SITES
(Studies with collection sites scattered throughout much of the area are not shown)



Map No.	Institution	Ref. No.	Data
1	Walla Walla College	2.5.4	Bird Counts
2	U.S. Fish & Wildlife Serv.	2.1.3	Pollutant Concentrations in Biota and Sediments
3	Battelle Northwest	2.8.4	Fecal Coliform

Figure 7

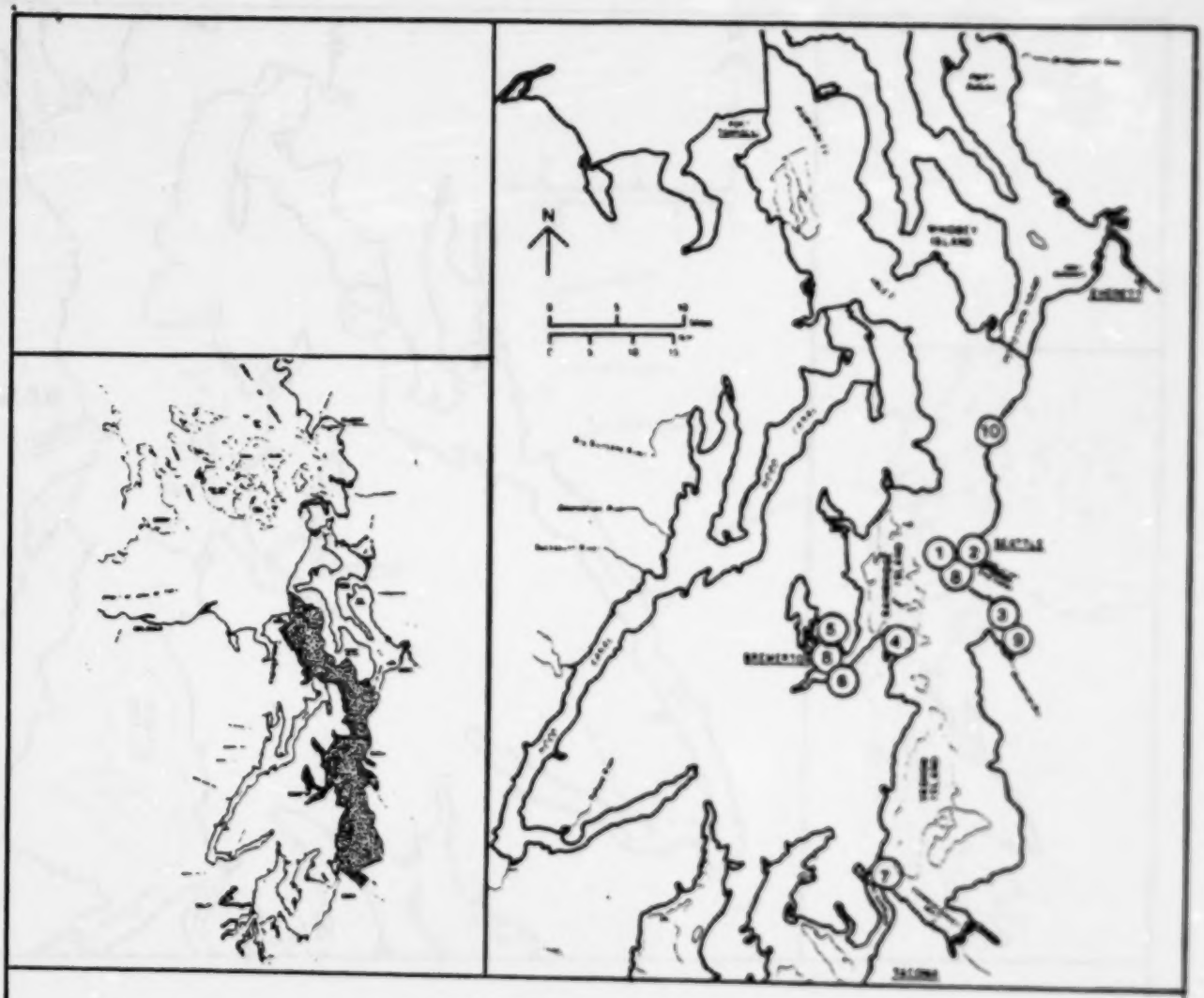
STRAIT OF JUAN de FUCA: LOCATION OF IDENTIFIED STUDY SITES



Map No.	Institution	Ref. No.	Data
1	Univ. of Washington	2.4.9	Hydrographic Data
2	Univ. of Washington	2.4.10	Salmon
3	Univ. of Washington	2.4.11	Ichthyoplankton
4	Univ. of Washington	2.4.12	Intertidal Biota
5	Univ. of Washington	2.4.13	Benthic Invertebrates
6	Univ. of Washington	2.4.14	Fishes
7	Univ. of Washington	2.4.15	Bifouling Organisms
8	Univ. of Washington	2.4.16	Zooplankton
9	U.S. Fish & Wildlife Serv.	2.1.3	Pollutant Concentrations in Biota and Sediment
10	U.S. Air Force, Mukilteo	2.1.6	Pollutant Conc. in Biota
11	Tulalip Tribes	2.10.3	Hydrography, Nutrients, Pollut.
12	Tulalip Tribes	2.10.4	Fishes.
Not Shown	Shoreline Comm. College	2.6.2	Intertidal Biota
Not Shown	Shoreline Comm. College	2.6.1	Benthic Invertebrates
Not Shown	U.S. Fish & Wildlife Serv.	2.1.1	Bird Counts

Figure 8

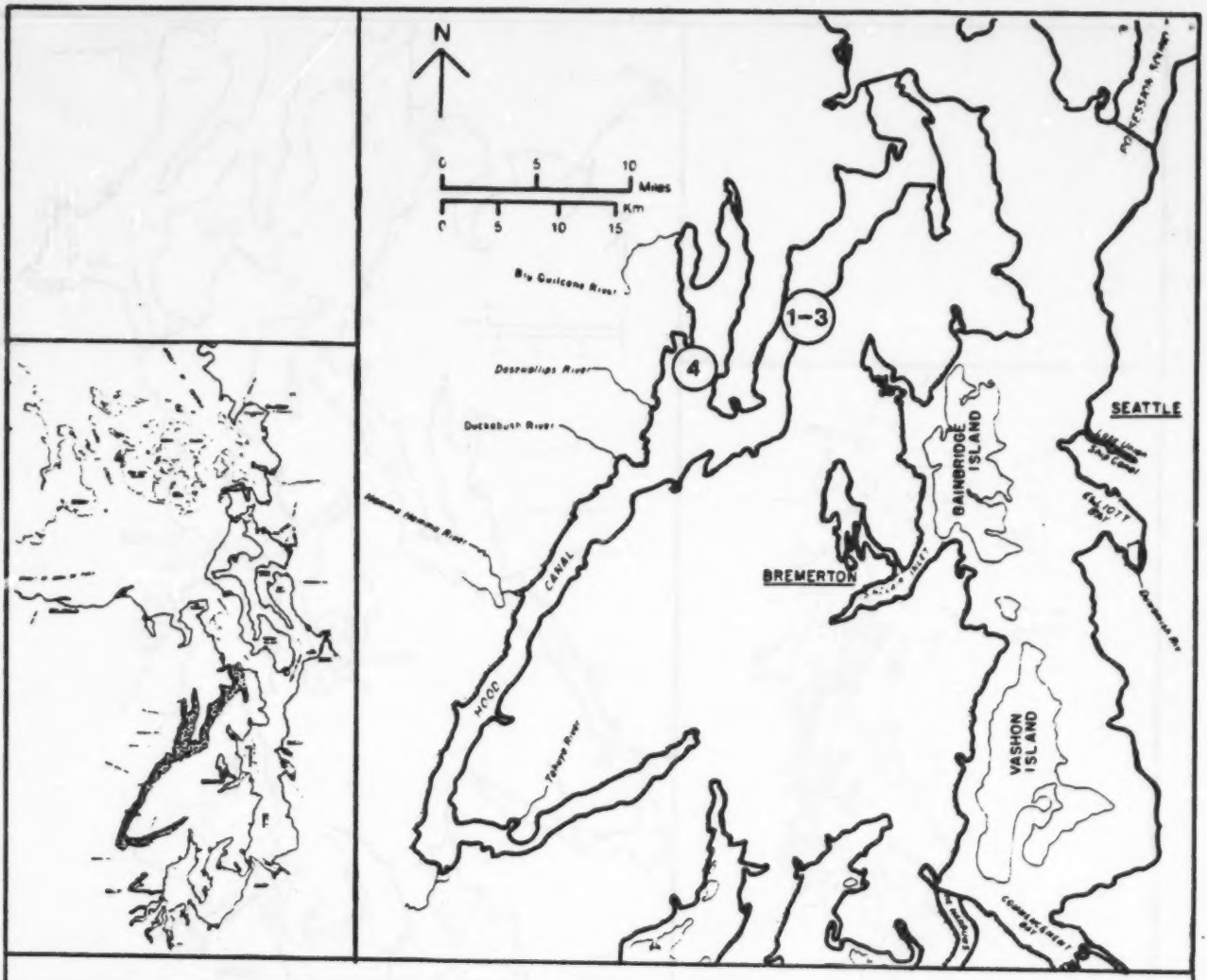
WHIDBEY BASIN: LOCATION OF IDENTIFIED STUDY SITES
(Studies with collection sites scattered throughout much of the area are not shown)



Map No.	Institution	Ref. No.	Data
1	Univ. of Washington	2.4.1	Zooplankton
2	Highland School District	2.7.1	Hydrographic Data
3	Seattle Aquarium	2.9.1	Hydrographic Data
4	Domsea Farms	2.10.1	Dissolved Oxygen
5	Olympic Comm. College	2.6.1	Fish and Invertebrates
6	Olympic Comm. College	2.6.3	Zooplankton & Hydrographic Data
7	Pt. Defiance Zoo & Aquarium	2.9.2	Hydrographic Data
8	Univ. of Washington	2.4.17	Barnacles
9	Univ. of Washington	2.4.6	Zooplankton
10	Univ. of Washington	2.4.7	Intertidal Biota
Not Shown	Shoreline Comm. College	2.6.2	Intertidal Biota
Not Shown	Shoreline Comm. College	2.6.1	Benthic Invertebrates
Not Shown	U.S. Fish & Wildlife Serv.	2.1.1	Bird Counts
Not Shown	Cascadia Research	2.8.1	Bird Counts
Not Shown	Evergreen State College	2.5.1	Pollutant Conc. in Biota
Not Shown	Kitsap County Health Dept.	2.3.2	Fecal Coliform, D.O.

Figure 9

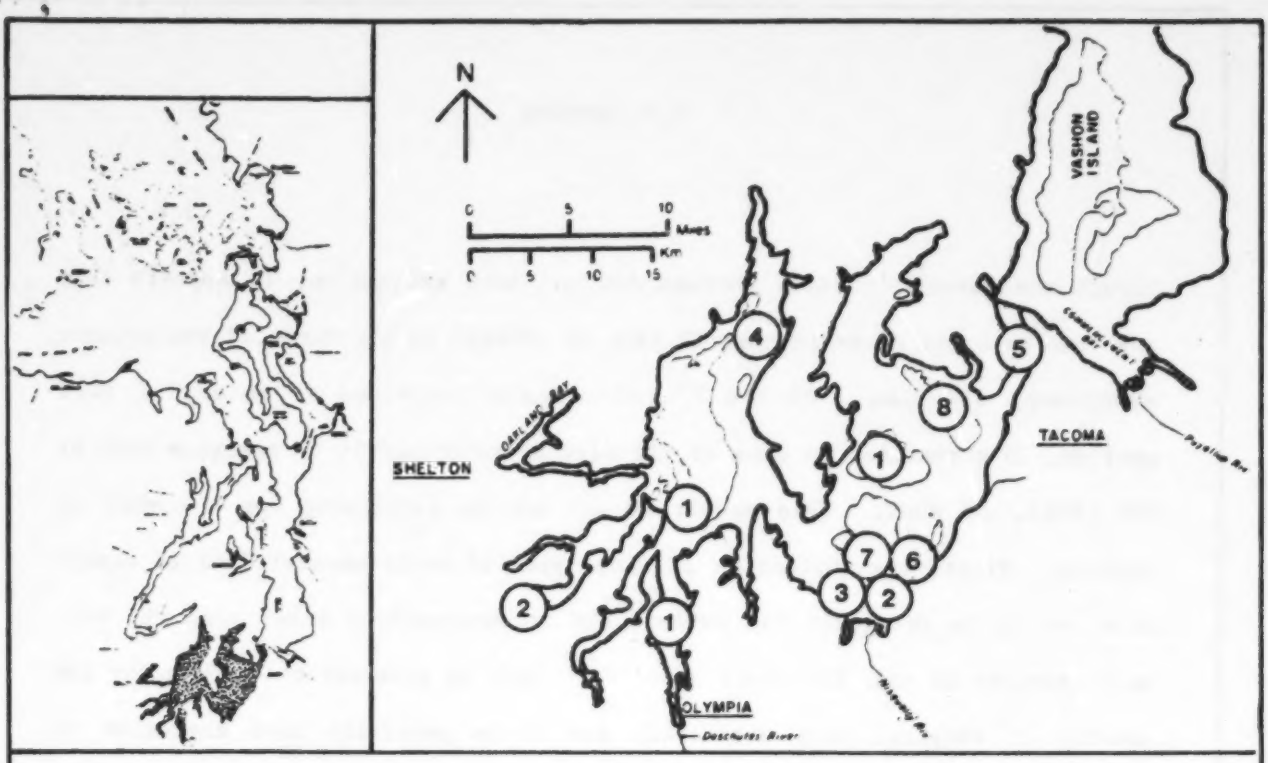
CENTRAL PUGET SOUND: LOCATION OF IDENTIFIED STUDY SITES
(Studies with collection sites scattered throughout much of the area are not shown)



Map No.	Institution	Ref. No.	Data
1	Univ. of Washington	2.4.6	Salmon and Zooplankton
2	U.S. Navy, Bangor	2.1.4	Metals, Nutrients, Hydrographic Data
3	U.S. Navy, Bangor	2.1.5	Fish and Invertebrates
4	Univ. of Washington	2.4.4	Phytoplankton
Not Shown	Kitsap Co. Health Dept.	2.3.2	Fecal Coliform, D.O.

Figure 10

HOOD CANAL: LOCATION OF IDENTIFIED STUDY SITES



Map No.	Institution	Ref. No.	Data
1	WA Dept. of Nat. Resources	2.2.2	Hydrographic Data
2	Evergreen State College	2.5.2	Bird Counts
3	Univ. of Washington	2.4.7	Fish & Zooplankton
4	Pacific Lutheran Univ.	2.4.18	Zooplankton
5	Univ. of Puget Sound	2.4.20	Hydrographic Data
6	Shoreline Comm. College	2.6.1	Benthic Invertebrates
7	Shoreline Comm. College	2.6.2	Intertidal Biota
8	Wash. Dept. of Fisheries	2.2.3	Hydrographic Data
Not Shown	U.S. Fish & Wildlife Serv.	2.1.1	Bird Counts
Not Shown	Cascadia Research	2.8.1	Bird Counts
Not Shown	Evergreen State College	2.5.1	Pollutant Conc. in Biota

Figure 11

SOUTHERN PUGET SOUND: LOCATION OF IDENTIFIED STUDY SITES
(Studies with collection sites scattered throughout much of the area are not shown)

4.0 SUMMARY

Though the search for data sources has not been exhaustive, it appears that the vast majority of environmental data is already in the hands of the primary management agencies. Of the 77 individuals contacted as potential data sources, 35 either had no data or had already submitted it to agencies such as EPA, NOAA, or WDOE. This result should not be surprising for a number of reasons. First, the collection of many types of environmental data is expensive and it is difficult for individuals or institutions other than the primary agencies to bear the costs involved. This is probably the reason for the paucity of chemical data uncovered, for it is generally more expensive to gather chemical data than either biological or hydrographic data. Secondly, with the exception of the universities and a few other groups, environmental data is not collected unless mandated by a governmental agency. Information gathered during studies required by a management agency, such as for 301h waivers or dredge and fill permits, is typically forwarded to these agencies and therefore beyond the scope of this task. For example, the ports of Seattle, Tacoma, Bellingham and Everett were all contacted as potential data sources. However none of these institutions collect any data that is not required by EPA or the Corp of Engineers and therefore already available to these agencies.

Efforts to date have resulted in the identification of approximately 50 data bases which may have escaped the attention of the primary management agencies. Many of these may be of little use for purposes of environmental monitoring because of narrowness of scope or inexperience on the part of those collecting

the data. However it is hoped that as development of a long-term monitoring program proceeds, a number of these data bases may prove valuable either by extension of the temporal coverage or by definition of baseline conditions.